From: Ramuhalli, Pradeep
To: Purtscher, Patrick
Subject: [External_Sender] RE: [External_Sender] Discuss Report Comments
Date: Tuesday, September 26, 2017 10:34:38 AM

Yes, but I will have to get off the call before 10 am Pacific (1 ET) as I have another meeting at that time. Any chance you are available later today (after 3 pm) or tomorrow (anytime – I am wide open)?
I will go ahead and get this moved by an hour just in case.
With best regards,
Pradeep Ramuhalli, PhD
Tel: 509-375-2763
Email: pradeep.ramuhalli@pnnl.gov
-----Original Appointment-----
From: Purtscher, Patrick [mailto:Patrick.Purtscher@nrc.gov]
Sent: Tuesday, September 26, 2017 3:08 AM
To: Ramuhalli, Pradeep
Subject: New Time Proposed: [External_Sender] Discuss Report Comments
When: Tuesday, September 26, 2017 8:30 AM-9:30 AM (UTC-08:00) Pacific Time (US & Canada).
Where: Call-in number below
I have had another meeting come up that I need to attend. Can we postpone our call for 1 hour?

From:	Ramuhalli, Pradeep
To:	Purtscher, Patrick; Hiser, Matthew
Subject:	[External_Sender] RE: [External_Sender] TLR Discussion
Date:	Wednesday, September 19, 2018 9:46:02 AM

Will do. Thanks.

With best regards,
Pradeep Ramuhalli, PhD
Tel: 509-375-2763
Email: pradeep.ramuhalli@pnnl.gov

From: Purtscher, Patrick [mailto:Patrick.Purtscher@nrc.gov]
Sent: Wednesday, September 19, 2018 3:48 AM
To: Hiser, Matthew <Matthew.Hiser@nrc.gov>; Ramuhalli, Pradeep <Pradeep.Ramuhalli@pnnl.gov>
Subject: RE: [External_Sender] TLR Discussion

Pradeep,
Can you create a new file with those changes we made that you agree are OK accepted, leaving our changes that you think need further consideration. If we could have that file before the Monday tele-con, it should make our discussion easier.
Pat

-----Original Appointment-----
From: Hiser, Matthew
Sent: Tuesday, September 18, 2018 8:16 PM
To: 'Ramuhalli, Pradeep'
Cc: Purtscher, Patrick
Subject: Tentative: [External_Sender] TLR Discussion
When: Monday, September 24, 2018 1:00 PM-2:00 PM (UTC-08:00) Pacific Time (US & Canada).
Where: Call info forthcoming

Hi Pradeep,
I have a meeting directly preceding this time that will probably run late. However, you and Pat can meet and I'll catch up when I can after my prior meeting.
Out of curiosity, have you had a chance to review our edits? Generally OK with you or many concerns?
Thanks!
Matt

From:	Ramuhalli, Pradeep
To:	Purtscher, Patrick
Cc:	Hiser, Matthew
Subject:	[External_Sender] RE: DMLR Specific Comments on PNNL-27120-pr nrc 9-7-18_w-PTP_add-ons.docx
Date:	Friday, September 07, 2018 5:47:58 PM

Pat,

Thanks. Let me review this next week, and we can talk afterwards. Perhaps towards the end of next week, or early the week after?

With best regards,
Pradeep Ramuhalli, PhD
Tel: 509-375-2763
Email: pradeep.ramuhalli@pnnl.gov

From: Purtscher, Patrick [mailto:Patrick.Purtscher@nrc.gov]
Sent: Friday, September 07, 2018 10:54 AM
To: Ramuhalli, Pradeep <Pradeep.Ramuhalli@pnnl.gov>
Cc: Hiser, Matthew <Matthew.Hiser@nrc.gov>
Subject: DMLR Specific Comments on PNNL-27120-pr nrc 9-7-18_w-PTP_add-ons.docx

Here is a copy of your report with all of our comments. We think this addresses the NRR comments and we hope it will be relatively easy for you to review, accepting those changes that you agree with. Where you don't agree, highlight them for our further discussion.

The one main comment I had that is not noted in each case is the rating or ranking that is present, mainly in Tables 1 through 4. It should be clearly noted where those values come from, some were from EMDA and others were from the author's assessment of the criteria in each table. Clearly the final assessment at the bottom of each table is TBD by each organization that is considering harvesting, given their own set of priorities.

Pat

From: Ramuhalli, Pradeep
To: Purtscher, Patrick
Subject: [External_Sender] RE: RE: draft report from PNNL on Harvesting project
Date: Wednesday, December 06, 2017 10:57:29 AM

Patrick,

An update. Looks like the internal approvals are moving along. I expect it to be approved for release later today or early tomorrow. I will get out an updated version of the document with the PNNL number as soon as this is approved.

With best regards,
Pradeep Ramuhalli, PhD
Tel: 509-375-2763
Email: pradeep.ramuhalli@pnnl.gov

From: Purtscher, Patrick [mailto:Patrick.Purtscher@nrc.gov]
Sent: Tuesday, December 05, 2017 7:21 AM
To: Ramuhalli, Pradeep <Pradeep.Ramuhalli@pnnl.gov>
Subject: RE: RE: draft report from PNNL on Harvesting project

Good morning,

Thanks for the report. When does this get a PNNL report #? I think it needs that before I can officially get this into the system.

Pat

From: Ramuhalli, Pradeep [mailto:Pradeep.Ramuhalli@pnnl.gov]
Sent: Monday, December 04, 2017 4:22 PM
To: Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Subject: [External_Sender] RE: draft report from PNNL on Harvesting project

Patrick,

I don't recall if I got this back to you or not. If not, attached is the updated version. In addition to the editorial changes you suggested, an internal peer review caught a few more editorial changes (format checks, grammatical issues). These are in the attached.

With best regards,
Pradeep Ramuhalli, PhD
Tel: 509-375-2763
Email: pradeep.ramuhalli@pnnl.gov

From: Purtscher, Patrick [mailto:Patrick.Purtscher@nrc.gov]
Sent: Friday, November 24, 2017 10:05 AM
To: Ramuhalli, Pradeep <Pradeep.Ramuhalli@pnnl.gov>
Subject: FW: draft report from PNNL on Harvesting project

Good afternoon,

Here is the report with some little editorial changes that we would like you to make before we send it through for management approval.

Pat

From:	Ramuhalli, Pradeep
To:	Purtscher, Patrick
Subject:	[External_Sender] RE: RE: MDLR comments on PNLL"s Guidelines for Harvesting Materials for SLR
Date:	Tuesday, April 03, 2018 11:17:56 AM

Would tomorrow afternoon work for you? Say around 3 pm eastern?

With best regards,
Pradeep Ramuhalli, PhD
Tel: 509-375-2763
Email: pradeep.ramuhalli@pnnl.gov

From: Purtscher, Patrick [mailto:Patrick.Purtscher@nrc.gov]
Sent: Tuesday, April 03, 2018 4:30 AM
To: Ramuhalli, Pradeep <Pradeep.Ramuhalli@pnnl.gov>
Subject: RE: RE: MDLR comments on PNLL's Guidelines for Harvesting Materials for SLR

Pradeep,
Sorry, I thought I had responded to your last message. I am available today or tomorrow in the afternoon (Eastern time). Pick a time that works for you and I will call you.
Pat

From: Ramuhalli, Pradeep [mailto:Pradeep.Ramuhalli@pnnl.gov]
Sent: Monday, April 02, 2018 5:23 PM
To: Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Subject: [External_Sender] RE: MDLR comments on PNLL's Guidelines for Harvesting Materials for SLR

Patrick,
Not sure if I missed an email from you, but are you available later this week to talk? Or early next week?

With best regards,
Pradeep Ramuhalli, PhD
Tel: 509-375-2763
Email: pradeep.ramuhalli@pnnl.gov

From: Purtscher, Patrick [mailto:Patrick.Purtscher@nrc.gov]
Sent: Monday, March 26, 2018 11:51 AM
To: Ramuhalli, Pradeep <Pradeep.Ramuhalli@pnnl.gov>
Subject: FW: MDLR comments on PNLL's Guidelines for Harvesting Materials for SLR

Hi,
I asked NRR for comments and never expected 8 people to review this report. After you have read the comments, we should schedule a time to talk. Let me know when you are ready.
Pat

From: Brady, Bennett
Sent: Tuesday, March 20, 2018 5:19 PM
To: Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Cc: Oesterle, Eric <Eric.Oesterle@nrc.gov>
Subject: MDLR comments on PNLL's Guidelines for Harvesting Materials for SLR

Pat
Following your request, I asked eight of our technical review staff to review and provide comments

on PNNL's technical letter report on harvesting materials. Attached are general comments on the report and specific comments that I have compiled in redline/strikeout version of the report itself. Some of the comments are repetitious of comments made by other reviews. I have tried to group similar comments together. When you have had a chance to review them, please see me if you have any questions. I will try to answer your questions or get you to the right reviewer.
In spite of the rather negative comments on this report, we continue to believe that the Materials Harvesting Project will be in valuable in the future as the NRC deals with aging plants and needs an organized approach for selecting materials for harvesting withe the increased availability of sources.
Bennett

Bennett M. Brady
Senior Project Manager
Division of License Renewal
Office of Nuclear Reactor Regulation
O 11 – D8
301-415-2981

From:	Ramuhalli, Pradeep
To:	Hiser, Matthew; Purtscher, Patrick; Knobbs, Katie
Cc:	Hull, Amy
Subject:	[External_Sender] RE: RE: RE: RRIM
Date:	Friday, August 05, 2016 11:40:09 AM

So – I have to be in a program review on the 30th in DC, so I cannot do that day either. I was planning on staying over on the 31st (at least for part of the day).

With best regards,
Pradeep Ramuhalli, PhD
Tel: 509-375-2763
Email: pradeep.ramuhalli@pnnl.gov

From: Hiser, Matthew [mailto:Matthew.Hiser@nrc.gov]
Sent: Friday, August 05, 2016 8:27 AM
To: Ramuhalli, Pradeep <Pradeep.Ramuhalli@pnnl.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>; Knobbs, Katie <katie.knobbs@pnnl.gov>
Cc: Hull, Amy <Amy.Hull@nrc.gov>
Subject: RE: RE: RE: RRIM

My two cents: I think it would be great if we could meet in-person the week of August 29. (I've been interacting with Pradeep on this for over a year without actually meeting!) My only limitation that week is I can't do August 30, but otherwise am fairly free… we could also meet somewhere downtown if that's easier for Pradeep.
If that won't work, perhaps a call on Aug 18, 19, 25, or 26? (Code is mostly Aug 22-24…)

From: Ramuhalli, Pradeep [mailto:Pradeep.Ramuhalli@pnnl.gov]
Sent: Friday, August 05, 2016 11:18 AM
To: Purtscher, Patrick <Patrick.Purtscher@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>; Knobbs, Katie <katie.knobbs@pnnl.gov>
Cc: Hull, Amy <Amy.Hull@nrc.gov>
Subject: [External_Sender] RE: RE: RRIM

Pat,

Thanks. Would the week of the 22nd work (not sure if Code week is that week, or the week after)?

Also, there is a good possibility I will be in DC the week of the 29th for at least a couple of days. I can always swing by and brief you, Matt, and Amy.

With best regards,
Pradeep Ramuhalli, PhD
Tel: 509-375-2763
Email: pradeep.ramuhalli@pnnl.gov

From: Purtscher, Patrick [mailto:Patrick.Purtscher@nrc.gov]
Sent: Friday, August 05, 2016 8:06 AM
To: Hiser, Matthew <Matthew.Hiser@nrc.gov>; Ramuhalli, Pradeep <Pradeep.Ramuhalli@pnnl.gov>; Knobbs, Katie <katie.knobbs@pnnl.gov>
Cc: Hull, Amy <Amy.Hull@nrc.gov>
Subject: RE: RE: RRIM

Good morning,

Matt and I have gone through the document and made some comments.
The timing for our next update will depend on a lot of factors. I will be out of the office on (b)(6) for part of the next 2 weeks and then we have ASME Code meetings here in DC the last week of August. Matt has (b)(6) in early September. Let me know when you think you would be ready for a conference call.
Pat

From: Ramuhalli, Pradeep [mailto:Pradeep.Ramuhalli@pnnl.gov]
Sent: Thursday, July 21, 2016 12:14 PM
To: Purtscher, Patrick <Patrick.Purtscher@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>; Knobbs, Katie <katie.knobbs@pnnl.gov>
Cc: Hull, Amy <Amy.Hull@nrc.gov>
Subject: [External_Sender] RE: RRIM

Patrick, Matt,

Attached is a draft document for discussion later today.

With best regards,
Pradeep Ramuhalli, PhD
Tel: 509-375-2763
Email: pradeep.ramuhalli@pnnl.gov

-----Original Appointment-----
From: Ramuhalli, Pradeep
Sent: Tuesday, July 12, 2016 7:50 AM
To: Ramuhalli, Pradeep; 'Purtscher, Patrick'; Hiser, Matthew (Matthew.Hiser@nrc.gov); Knobbs, Katie
Cc: Hull, Amy
Subject: RRIM
When: Thursday, July 21, 2016 10:00 AM-11:00 AM (UTC-08:00) Pacific Time (US & Canada).
Where: Skype Meeting

All,

Apologies – I have been incommunicado for a couple of weeks. I'd like to set up a conference call to play catch up. Let me know if this time works for you.

→ Join Skype Meeting

This is an online meeting for Skype for Business, the professional meetings and communications app formerly known as Lync.

Join by phone

Join the meeting and have Lync call you or dial-in (Richland) English (United States)
866-528-1882 or 509-375-4555 (Richland) English (United States)
On-campus PNNL staff dial 5-4555 (Richland) English (United States)
Find a local number
Conference ID: (b)(6)
Forgot your dial-in PIN? | Help

From:	Ramuhalli, Pradeep
To:	Purtscher, Patrick; Hiser, Matthew
Subject:	[External_Sender] RE: RE: TLR Update
Date:	Thursday, August 30, 2018 12:35:38 PM

Patrick,

No problem. I will wait till next week for the updated file.

With best regards,
Pradeep Ramuhalli, PhD
Tel: 509-375-2763
Email: pradeep.ramuhalli@pnnl.gov

From: Purtscher, Patrick [mailto:Patrick.Purtscher@nrc.gov]
Sent: Thursday, August 30, 2018 5:50 AM
To: Ramuhalli, Pradeep <Pradeep.Ramuhalli@pnnl.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>
Subject: RE: RE: TLR Update

Hi,

I made a mistake and the file I sent on Wednesday did not include all of the comments. We are preparing a comprehensive file that should be ready by the end of next week with comments/changes that you can more easily review and either accept or reject. Those areas that you reject can be the areas where we can focus our discussions to finalize the report.

Thanks,

Pat

From: Ramuhalli, Pradeep [mailto:Pradeep.Ramuhalli@pnnl.gov]
Sent: Wednesday, August 29, 2018 12:51 PM
To: Purtscher, Patrick <Patrick.Purtscher@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>
Subject: [External_Sender] RE: TLR Update

Patrick,

Thanks. Let me review and we can talk. I am out of the office for most of the rest of this week and next; how about Tuesday Sept 11? In principle, what you suggest below seem to be OK but let me take a look through the document as well.

With best regards,
Pradeep Ramuhalli, PhD
Tel: 509-375-2763
Email: pradeep.ramuhalli@pnnl.gov

From: Purtscher, Patrick [mailto:Patrick.Purtscher@nrc.gov]
Sent: Wednesday, August 29, 2018 9:43 AM
To: Ramuhalli, Pradeep <Pradeep.Ramuhalli@pnnl.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>
Subject: RE: TLR Update

Hi,

Matt and I took turns changing the report with our recommendations, the attached is a composite of our comments. The biggest changes were to drop the abstract, combine sections 1 and 2, make the examples in section 3.3.2 into a separate section, and drop the specific harvesting examples in Section 4. We don't need that level of details for historical perspective. The general lessons learned are the points to be emphasized.

These are suggestions and would like to discuss with you after you have some time to review. Let me

know when you have time. We hope to meet with NRR near the end of Sept. to go over the report and how their comments were considered.

Pat

From: Ramuhalli, Pradeep [mailto:Pradeep.Ramuhalli@pnnl.gov]
Sent: Friday, August 17, 2018 2:45 PM
To: Hiser, Matthew <Matthew.Hiser@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Subject: [External_Sender] TLR Update

The update so far is attached. This still needs some cleanup and citations included; I am working on a tech editor on these.

With best regards,

Pradeep

Pradeep Ramuhalli, PhD
Senior Research Scientist,
Applied Physics Group
Pacific Northwest National Laboratory
902 Battelle Blvd.
P.O.Box 999, MSIN K5-26
Richland, WA 99352
Tel: 509-375-2763
Email: pradeep.ramuhalli@pnnl.gov
http://www.pnnl.gov

Note to requester: Attachment to this email is immediately following.

From: Hull, Amy
To: Hiser, Matthew
Subject: abstract size constraints ?: Ditto to Rob [eom]: ACTION: PLiM abstract - revised
Date: Monday, May 22, 2017 3:12:15 PM
Attachments: Abstract for 4th PLiM_NRC RES SLR.docx

From: Moyer, Carol
Sent: Monday, May 22, 2017 10:56 AM
To: Hull, Amy <Amy.Hull@nrc.gov>; Tregoning, Robert <Robert.Tregoning@nrc.gov>; Frankl, Istvan <Istvan.Frankl@nrc.gov>
Subject: RE: Ditto to Rob [eom]: ACTION: PLiM abstract - revised

Thank you all. I will submit this abstract today.
Separately, I believe Matt H. is drafting an abstract on harvesting. I hope that it, too, will be well received.
Carol

From: Hull, Amy
Sent: Monday, May 22, 2017 10:35 AM
To: Tregoning, Robert <Robert.Tregoning@nrc.gov>; Moyer, Carol <Carol.Moyer@nrc.gov>; Frankl, Istvan <Istvan.Frankl@nrc.gov>
Subject: Ditto to Rob [eom]: ACTION: PLiM abstract - revised

From: Tregoning, Robert
Sent: Monday, May 22, 2017 10:08 AM
To: Moyer, Carol <Carol.Moyer@nrc.gov>; Frankl, Istvan <Istvan.Frankl@nrc.gov>
Cc: Hull, Amy <Amy.Hull@nrc.gov>
Subject: RE: ACTION: PLiM abstract - revised

Carol:
I'm okay with it. I would just read it through one more time before sending to make sure that there are no grammatical errors in the final product.
Cheers,
Rob

Robert Tregoning
Technical Advisor for Materials
US Nuclear Regulatory Commission
Two White Flint North, M/S T-10 A36
11545 Rockville Pike
Rockville, MD 20852-2738
ph: 301-415-2324
fax: 301-415-6671

From: Moyer, Carol
Sent: Monday, May 22, 2017 9:59 AM
To: Frankl, Istvan <Istvan.Frankl@nrc.gov>
Cc: Tregoning, Robert <Robert.Tregoning@nrc.gov>; Hull, Amy <Amy.Hull@nrc.gov>
Subject: RE: ACTION: PLiM abstract - revised

Steve,
Thank you for your review. I agree with your recommended changes.
Amy, Rob – Still OK with this?

Thank you,
Carol

From: Frankl, Istvan
Sent: Friday, May 19, 2017 5:53 PM
To: Moyer, Carol <Carol.Moyer@nrc.gov>
Cc: Tregoning, Robert <Robert.Tregoning@nrc.gov>; Hull, Amy <Amy.Hull@nrc.gov>
Subject: RE: ACTION: PLiM abstract - revised

Thanks, Carol.
I would recommend change in title. Please see the attachment for additional revisions.
Steve

From: Moyer, Carol
Sent: Friday, May 19, 2017 5:03 PM
To: Frankl, Istvan <Istvan.Frankl@nrc.gov>
Cc: Tregoning, Robert <Robert.Tregoning@nrc.gov>; Hull, Amy <Amy.Hull@nrc.gov>
Subject: ACTION: PLiM abstract - revised

Steve,
The draft abstract for our paper for the Plant Life Management (PLiM) conference is included below, for easy access, and attached, for track-changes use if needed. This version addresses comments from Amy, Mita, and Rob. I have asked Sherry Bernhoft, who is on the organizing committee, to confirm that we can submit the abstract early next week. I will let you know when I learn her true deadline or any other new info. Comments and suggestions are appreciated.

Research Relating to Plant License Renewal and Aging Management

C. E. Moyer, M. Sircar, J. Philip, J. E. Pires, D. D. Murdock, T. Koshy, A. B. Hull
U.S. Nuclear Regulatory Commission (NRC), Washington, D.C., USA

The U.S. Nuclear Regulatory Commission (NRC) issues licenses for commercial power reactors to operate for up to 40 years. These licenses may be renewed by the regulator for multiple 20-year increments. Now that 47 of the 99 operating commercial reactors in the U.S. have entered their first period of extended operation (PEO), several licensees have indicated their intention to apply within the next few years for subsequent license renewal (SLR) for an additional 20-year period. The NRC has revised its key guidance documents to indicate its expectations for aging management of passive, long-lived plant systems, structures, and components. Research is being continued beyond the receipt of initial SLR applications to confirm the adequacy of these guidance documents through the SLR period. Should the research identify concerns related to aging management, the guidance may need to be revised to reflect the new results. Research is ongoing in the following four areas: reactor pressure vessel neutron embrittlement, irradiation assisted stress corrosion cracking of reactor vessel internals, concrete and containment degradation, and electrical cable qualification and condition assessment. This paper will emphasize research related to concrete degradation, including alkali-silica reaction and irradiation damage to concrete, and condition assessment of electrical cables.

Carol Moyer
Sr. Materials Engineer

RES/DE/CMB
carol.moyer@nrc.gov
301-415-2153

Proposed Abstract for 4th PLiM
C. Moyer (RES/DE/CMB)
5/19/2017

Regulatory Research on the Aging Management of Structures, Systems and Components in Nuclear Power Plants Supporting License Renewal

C. E. Moyer, M. Sircar, J. Philip, J. E. Pires, D. D. Murdock, T. Koshy, A. B. Hull
U.S. Nuclear Regulatory Commission (NRC), Washington, D.C., USA

The U.S. Nuclear Regulatory Commission (NRC) issues licenses for commercial power reactors to operate for up to 40 years. These licenses may be renewed for multiple 20-year increments. Now that 47 of the 99 operating commercial reactors in the U.S. have entered their first period of extended operation (PEO) to operate for up to 60 years, several licensees have indicated intention to apply within the next few years for subsequent license renewal (SLR) for an additional 20-year period. The NRC has revised its key guidance documents to be ready for the review of SLR applications and to communicate expectations for the aging management of passive, long-lived plant systems, structures, and components (SSCs). Regulatory research on the aging management of SSCs is being conducted now and will continue beyond the receipt of the initial SLR applications to confirm the adequacy of these guidance documents through the SLR period. Should regulatory research identify concerns related to aging management, regulatory guidance may be revised to reflect the new results. Regulatory research is ongoing in the following four areas: reactor pressure vessel neutron embrittlement, irradiation assisted stress corrosion cracking of reactor vessel internals, concrete and containment degradation, and electrical cable qualification and condition assessment. This paper will focus on regulatory research related to concrete degradation, including alkali-silica reaction and irradiation damage to concrete, and condition assessment of electrical cables.

Note to requester: Attachment to this email is immediately following.

From: Frankl, Istvan
To: Moyer, Carol; Hiser, Matthew
Subject: ACTION: Inputs for EPRI quarterly MOU call
Date: Tuesday, October 17, 2017 10:32:28 AM
Attachments: EPRI Quarterly MOU Status Update Oct 2017_cem20171011.xlsx
Importance: High

Carol,
Brian needs additional info on harvesting for the upcoming EPRI quarterly MOU call on 11/3.
Please address the highlighted request below in your reply and update relevant section of the attached spreadsheet.
Please complete this action by noon tomorrow.
Matt,
Please assist Carol with this action.
Thanks,
Steve

From: Thomas, Brian
Sent: Tuesday, October 17, 2017 10:11 AM
To: Oberson, Greg <Greg.Oberson@nrc.gov>; Frankl, Istvan <Istvan.Frankl@nrc.gov>; Iyengar, Raj <Raj.Iyengar@nrc.gov>; Koshy, Thomas <Thomas.Koshy@nrc.gov>; Miller, Kenneth A <KennethA.Miller@nrc.gov>; Boyce, Tom <Tom.Boyce@nrc.gov>
Cc: Regan, Christopher <Christopher.Regan@nrc.gov>
Subject: RE: Inputs for EPRI quarterly MOU call

Folks,
The status update for the action items for CMB, ICEEB, and RGGIB needs improvement.
For CIB - I am not aware of any deep dive meetings occurring. Specific accomplishments for such meetings should be identified. Neither I nor Chris attended nor were invited to any such meeting. Information stated was already known and does not portray any progress on the action item.
For cable harvesting – please state what was done to enable the completion of the harvesting. Also state what other collaborative activities are needed regarding cable research at this time?
For RGGIB/Codes and Standards - please state what occurred or was agreed to going forward at the Standards Forum.
Thanks… Brian

From: Oberson, Greg
Sent: Monday, October 16, 2017 4:40 PM
To: Thomas, Brian <Brian.Thomas@nrc.gov>
Cc: Regan, Christopher <Christopher.Regan@nrc.gov>
Subject: Inputs for EPRI quarterly MOU call

Brian,
Attached are the inputs for your consideration. I would like to provide these to Nick by Wednesday if possible.
Greg

Action Item	Assignment	Status Update	Challenges/Issues for Management Attention
Review the availability of cables that could be harvested from plants in decommissioning to support research on cable aging and performance under realistic conditions. Elevate as needed to EPRI and NRC management to facilitate successful availability.	CMB	Cables to be harvested for the current research project on cable condition assessment and cable degradation is completed.	EPRI and NRC management and staff should be encouraged to continue awareness of decommissioning NPPs in order to identify potential components for future harvesting. NRC/RES is undertaking a research project to prioritize components for harvesting that will support aging management studies for SLR, including electrical components.
Schedule “deep dive” meetings on LTO RPV/ Concrete / Cables research within the near-term (3-6 months) to assess the status of roadmap activities, identify remaining gaps in Research, determine what research remains to be completed, and when can we terminate these research projects (e.g., concrete irradiation). Additionally, identify options to complete the research in an efficient manner and that optimizes use of available resources. Assess readiness for potential utility submittals by Dec 2017. Use these updated roadmaps to complete remaining research in support of long-term operations.	CMB	EPRI/NRC "deep dives" have been completed. RPVs & Internals: A public workshop on RPVs and internals is planned for Spring 2019. Concrete: A joint (NRC/DOE/EPRI) roadmap meeting on concrete is expected in Q4 of CY2017. Cables: A joint roadmap meeting on cables is scheduled for 1/8/2018. A public workshop on concrete and cables is planned for Summer 2020. Based on confirmatory research to date, the NRC is ready to receive utility submittals in Dec. 2017. The joint roadmap process is being used to track completion of remaining research in support of LTO.	EPRI and NRC management and staff should be encouraged to continue participation in the joint roadmap process to track completion of confirmatory research for LTO, as well as to identify any emerging opportunities for leveraging or otherwise accelerating completion of the work. Lessons learned from reviews and implementation of the lead SLR applications will be fed back into the joint roadmap process.
Identify if there are opportunities for an earlier SLR workshop in 2017 in advance of the first SLR application by the end of the year.	CMB	After discussions with RES and EPRI staff, it was determined that an SLR workshop in 2017 would not be timely. Near-term applicants are in the peer-review phase, and unlikely to modify applications. Workshops would be more effective after lessons learned from addressing the lead applications. Public workshops on SLR are being planned for Spring 2019 (RPVs and Internals) and Summer 2020 (Concrete and Cables).	
Develop technical addendum on advanced reactor materials research which identify planned NRC and EPRI cooperation. Focus on aligning efforts and avoiding unnecessary duplication of activities. Target end of the year.	CIB		

Forward to Kurt by the end of June the invite to the September 2017 Standards Forum meeting, which NRC is hosting.	RGGIB	Brian Thomas sent an email to Kurt Edsinger on 6/28 inviting EPRI to the NRC Standard Forum, and requesting that EPRI make their reports publicly available so they can be used for standards. Kurt replied on 6/30 that EPRI would support the Forum, and would likely make their reports available to those interested.	Kurt E. suggested that we make use of EPRI reports a topic for a quarterly meeting or a face-to-face meeting. We could also explore whether EPRI could get vendors to particpate in using the reports and creating standards.
Work with legal staff to enable domestic distribution of the xLPR code and facilitate future international distribution. Explore viable and practical approaches, such as distributing the code to international non-governmental entities through RISSC.	CIB		

From:	Frankl, Istvan
To:	Purtscher, Patrick
Subject:	ACTION: harvesting report
Date:	Friday, May 25, 2018 11:04:23 AM
Importance:	High

Pat,

What is the latest status of the PNNL report? Can we prioritize its publication?

Thanks,

Steve

From: Hiser, Matthew
Sent: Thursday, May 24, 2018 12:09 PM
To: Tregoning, Robert <Robert.Tregoning@nrc.gov>; Audrain, Margaret <Margaret.Audrain@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Cc: Frankl, Istvan <Istvan.Frankl@nrc.gov>
Subject: RE: harvesting report

I agree it would be good to move the publishing of that report ahead expeditiously to help our coordination with EPRI. Last I heard Pat said PNNL was working on addressing NRR's comments – not sure what the timeline was for doing that though.

Thanks!
Matt

From: Tregoning, Robert
Sent: Thursday, May 24, 2018 8:37 AM
To: Audrain, Margaret <Margaret.Audrain@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Cc: Frankl, Istvan <Istvan.Frankl@nrc.gov>
Subject: harvesting report

All:

Yesterday, during Steve's presentation, EPRI (Dyle and Demma) expressed interest in getting the PNNL report once it's published. We're also planning to have some discussions with EPRI next week during the NRC/EPRI materials meeting to promote future collaboration on harvesting opportunities. Therefore, I think we should make publishing that report a higher priority and we can possibly use it in part to help frame our discussions with EPRI moving forward.

Thoughts?

Rob

Robert Tregoning
Technical Advisor for Materials
US Nuclear Regulatory Commission
Two White Flint North, M/S T-10 A36
11545 Rockville Pike
Rockville, MD 20852-2738
ph: 301-415-2324
fax: 301-415-6671

From:	Hull, Amy
To:	Tregoning, Robert; Hiser, Matthew
Subject:	ADAMS address to obtain other presentations?: source doc for DOE slide: Harvesting Efforts June NRC-Industry materials mtg 5-28-15 mah.abh.pptx
Date:	Monday, June 01, 2015 12:07:35 PM

Thanks. I am working at home. How do I access other presentations?

_____

From: Tregoning, Robert
Sent: Monday, June 01, 2015 11:12 AM
To: Hiser, Matthew
Cc: Hull, Amy
Subject: RE: source doc for DOE slide: Harvesting Efforts June NRC-Industry materials mtg 5-28-15 mah.abh.pptx

Got you; I didn't read the entire thread to really grasp the issue…

Robert Tregoning
Technical Advisor for Materials
US Nuclear Regulatory Commission
21 Church Street, M/S CS-5A24
Rockville, MD 20850
ph: 301-251-7662
Blackberry: [redacted] (b)(6)
fax: 301-251-7425

From: Hiser, Matthew
Sent: Monday, June 01, 2015 11:11 AM
To: Tregoning, Robert
Cc: Hull, Amy
Subject: RE: source doc for DOE slide: Harvesting Efforts June NRC-Industry materials mtg 5-28-15 mah.abh.pptx

Hi Rob,

What you have is the final version. There was a comment from Kathy about cleaning up Slide 15, but the slide was a screenshot from a DOE presentation that Amy has only in PDF form, so it's not possible to fix the formatting (nor desirable really given that it is someone else's slide…).

Thanks!
Matt

Matthew Hiser
Materials Engineer
Corrosion and Metallurgy Branch
Division of Engineering
Office of Nuclear Regulatory Research
301-251-7601

From: Tregoning, Robert
Sent: Monday, June 01, 2015 11:08 AM
To: Hiser, Matthew
Cc: Hull, Amy
Subject: RE: source doc for DOE slide: Harvesting Efforts June NRC-Industry materials mtg 5-28-15 mah.abh.pptx

Matt/Amy:

Here's the powerpoint that I have if you need it. Please send me any changes that you make to this so that I can make sure the latest version is available for presenting.

RT

Robert Tregoning
Technical Advisor for Materials
US Nuclear Regulatory Commission
21 Church Street, M/S CS-5A24
Rockville, MD 20850
ph: 301-251-7662
Blackberry: (b)(6)
fax: 301-251-7425

From: Hiser, Matthew
Sent: Monday, June 01, 2015 10:39 AM
To: Frankl, Istvan
Cc: Hull, Amy; Tregoning, Robert
Subject: FW: source doc for DOE slide: Harvesting Efforts June NRC-Industry materials mtg 5-28-15 mah.abh.pptx

FYI Steve – it appears Amy has the source slide only in pdf form, so it is not possible to make these changes. I think it works fine as is to convey the necessary information for our purposes…

From: Hull, Amy
Sent: Monday, June 01, 2015 7:35 AM
To: Hiser, Matthew
Subject: source doc for DOE slide: Harvesting Efforts June NRC-Industry materials mtg 5-28-15 mah.abh.pptx

Matt, I 'snipped' slide 13 of the attached pdf. I could not figure out how to clean it up. Are you able to?

From: Hiser, Matthew
Sent: Friday, May 29, 2015 9:39 AM
To: Hull, Amy; Frankl, Istvan
Cc: Tregoning, Robert
Subject: RE: Harvesting Efforts June NRC-Industry materials mtg 5-28-15 mah.abh.pptx

Hi Rob, Steve, Amy,

I have made the changes in accordance with Kathy's comments as relayed by Steve in the attached PP. One final tweak Amy and I will try to make on Monday is to Slide 15 – if we can clean up the source slide from DOE, just so the information comes through clearly.

Thanks!
Matt

From: Hull, Amy
Sent: Thursday, May 28, 2015 10:03 AM
To: Frankl, Istvan
Cc: Tregoning, Robert; Hiser, Matthew
Subject: Harvesting Efforts June NRC-Industry materials mtg 5-28-15 mah.abh.pptx

We have made changes suggested. I will drop the 390 form off for you now.

From: Hull, Amy
To: Moyer, Carol; Burke, John; Herrity, Thomas; Hiser, Matthew; Audrain, Margaret; Purtscher, Patrick; Tregoning, Robert; Harris, Brian
Cc: Frankl, Istvan
Subject: Analysis of reception of our RIC posters, thanks for your participation,
Date: Friday, March 16, 2018 8:58:55 AM

RIC poster outreach metrics parameter	AM	Harvesting
# of poster handouts taken to exhibit	75	120
# of poster handouts remaining on 3/16/2018	1	47
# posters picked up by visitors	74	73
# people noted on contact/interest/signin form	20	27
# of business cards completed, left at exhibit	13	16
completed detailed interest form	7	5

Amy B. Hull, PhD
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From:	Audrain, Margaret
To:	Hiser, Matthew; Purtscher, Patrick
Subject:	ANL Harvesting Trip
Date:	Thursday, November 16, 2017 2:05:56 PM

First attempt at ANL letter. Edit away!
Bodgan et all,
A few of us at the NRC (Matt Hiser, Pat Purtscher, Rob Tregoning, and me), are setting up a database of materials for a harvesting program. We'd like to schedule a visit to ANL to be our "guinea pig" site to get rolling with the effort.
We have four main material areas of interest: RPV, RVI, cables, & concrete and are interested in what ANL has from past programs with the NRC, DOE and others.
We hope to assemble an inventory of available materials to consider for a harvesting program like, or in coordination with, that in the INL NSUF Nuclear Fuels and Materials Library (NFML). Our emphasis is in the four areas outlined earlier, but not necessarily limited to those four. Materials of interest don't have to be material from plants with extensive service history.
Would you all be available and have the resources to meet with us to go over the materials ANL has in inventory? We hope that all of you, with the assistance of Omesh Chopra and Bill Shack, will be able to identify materials of interest before we make the trip. This would be some preliminary work on your part and then roughly a half day in person.
We are thinking about planning the trip mid-Dec. Would this give you enough time to compile material of potential interest? We can have a phone call in advance to better describe what we're looking for if that would help.
Thanks,
Meg, Matt, Pat and Rob

From: Brady, Bennett
To: Purtscher, Patrick
Subject: Comments on PNNL Report
Date: Wednesday, March 07, 2018 11:20:18 AM

Pat,
I just got some more comments from Allen Hiser. I am incorporating them in the redline/strikeout version and in the general comments. You may want to delay your review of the comments I sent yesterday until I have them all. I will try to get them to you by the end of the week.
Bennett

Bennett M. Brady
Senior Project Manager
Division of License Renewal
Office of Nuclear Reactor Regulation
O 11 – D8
301-415-2981

Criteria Title	Description	Scoring Guidance	
Criticalness of Technical Gap Addressed	Harvesting to address critical gaps should be prioritized over less essential technical gaps	**H = high risk significance / little to no available data** **MH = Medium-high risk significance / limited data available** **M = Moderate risk significance / some data available** **ML = low to moderate risk signficance / sufficient data available for regulatory decisions** **L = Low risk significance / large amount of data available**	**H = High** **MH = Medium-high** **M = Medium** **ML = Medium-low** **L = Low**
Importance of Harvested Materials over Laboratory Aging	Key considerations are the ease of laboratory replication of aging mechanism and unique field aspects of the aging mechanism. Degradation mechanisms that are harder to replicate with simulated aging conditions would be of higher priority for harvesting. For example, simultaneous thermal and irradiation conditions are difficult to replicate outside of the plant environment. Alternatively, accelerated aging may not be feasible for a mechanism sensitive to dose rate. These two degradation mechanisms may be best evaluated using harvested materials. For unique field aspects, legacy materials (e.g., fabrication methods, composition) that are no longer available, but may play an important role in a potential degradation mechanism, would have a higher priority than harvesting materials that can be obtained from other sources with representative properties.	**H = Nearly impossible to replicate service enviroment / critically important to use harvested materials** **MH = Challenging to replicate service enviroment / important to use harvested materials** **M = Possible with some limitations to replicate service enviroment / moderately important to use harvested materials** **ML = Not challenging to replicate service enviroment / less important to use harvested materials** **L = Very easy to replicate service enviroment / not important to use harvested materials**	
Applicability to US Operating Fleet	There is greater value in developing knowledge to address an issue that may be applicable to a larger number of plants compared to one that may only affect a relatively small number of plants.	**H = All plants** **MH = All PWRs** **M = All BWRs or most PWRs** **ML = ~10-15 plants** **L = <5 plants**	
Regulatory Considerations Related to Inspections and AMPs	If mature inspection methods exist and are easy to apply to monitor degradation, harvesting may be less valuable. If inspection methods do not exist, harvesting may be essential to ensure confidence in the assessment of age-related degradation in that particular component.The less confidence that NRC staff has in the effectiveness of the relevant AMP, the higher priority for harvesting.	**H = No or very limited inspection methods available / low confidence in AMPs** **MH = Limited inspection methods available / low-to-moderate confidence in AMPs** **M = Some inspection methods available / moderate confidence in AMPs** **ML = Good inspection methods available / medium-high confidence in AMPs** **L = Effective, well-accepted inspection**	
Harvesting cost and complexity	Activities with higher costs and complexity are less attractive than similar activities with lower costs and that are simpler to execute.. For example, harvesting unirradiated concrete or electrical cables is less expensive and less complex than harvesting from the RPV internals or the RPV.	**H = Highly irradiated (>5 dpa)** **MH = Lightly irradiated / contaminated** **M = Minimal contamination or high effort unirradiated** **ML = Unirradiated, moderate effort expected** **L = Unirradiated, low effort expected**	
Timeliness of results	The ability of a potential harvesting program to provide timely results to support either a technical or regulatory need is important. Having high confidence that results will be timely increases the priority.		
Availability of materials for harvesting	The availability of materials to harvest for a particular data need is clearly essential and increases the priority.		

	Basic Info		Technical Criteria										Cost / Complexity		Project Specific	
Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Criticalness of Technical Gap Addressed		Importance of Harvested Materials over Laboratory Aging		Applicability to US Operating Fleet		Regulatory Considerations Related to Inspections and AMPs		Score Average	Basis for Technical Priority			Timeliness of results	Availability of materials for harvesting
RPV			Score	Comment	Score	Comment	Score	Comment	Score	Comment			Score	Comment		
RPV - High fluence & high shift vessel with well-established unirradiated properties	Measure fluence, toughness, & chemistry as a function of through-thickness position	Through thickness section to validate fluence & attenuation models	M	This work has been done before but the additional work should focus on higer fluences to verify that the attenuation trends expected are maintained.	MH	There are not many studies that irradiate 6 to 9 inches of steel so, from that standpoint, getting specimens from an RPV are important for studying attenuation	M	While the information should be generically appricable, if, for some reason, the results are only applicable to "high fluence" materials/locations, this might result in less relevance to lower fluence plants (including BWRs).	ML	The attenuation models have the least amount of supporting information compared to other aspects related to RPV embrittlement. However, studies to date have validated the conservativism of existing atttenuation models used in regulatory applications.	**M**	The attenuation study is slightly more important to me, just because there are fewer such studies that have been done. Being able to confirm expected trends at higher fluence levels would therefore be useful.	MH	Material is irradiated which will affect all aspects of specimen preparation and testing. Further, taking specimens at several through-thickness locations will increase cost.	The results would be timely if they are developed before 2024 or so to coincide with the additional information being collected from industry surviellance programs.	Other than Zion materials, I'm not aware of other RPVs that are available for harvesting.
RPV - Samples from virtually any vessel	Enable measurement of both the Charpy transition curve and master curve transition temperature T0	Provides data supporting evolution from the use of correlative (Charpy-based) to direct measurement (fracture toughness-based) approaches	M	I believe that enough data has been developed from both test and surveillance specimens such that the link is well-established. I will say that there is	ML	The only real advantage in my mind for having vessel material for this study is that there are no questions about the representativeness of any lead-factor irradiation compared to the actual vessel irradiation.	MH	Any information developed should be generically applicable	ML	We have as good a confidence in RPV embrittlement than virtually any other degradation that we study. The only real issue is making sure that our understanding remains applicable at the highest expected fluences.	**M - ML**	While it's always useful to have more data, especially on RPV materials, I feel that our models already have a good technical basis.	MH	Material is irradiated which will affect all aspects of specimen preparation and testing.	The results would be timely if they are developed before 2024 or so to coincide with the additional information	Other than Zion materials, I'm not aware of other RPVs that are available for harvesting.

	Basic Info		Technical Criteria										Cost / Complexity		Project Specific	
Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Criticalness of Technical Gap Addressed		Importance of Harvested Materials over Laboratory Aging		Applicability to US Operating Fleet		Regulatory Considerations Related to Inspections and AMPs		Score Average	Basis for Technical Priority			Timeliness of results	Availability of materials for harvesting
RPV			Score	Comment	Score	Comment	Score	Comment	Score	Comment			Score	Comment		
RPV - High fluence & high shift vessel with well-established unirradiated properties	Measure fluence, toughness, & chemistry as a function of through- thickness position	Through thickness section to validate fluence & attenuation models	MH	Score is MH within the beltline. Change to H beyond the beltline	MH	Again change to H outside of beltline	MH		#N/A	embrittlement is not inspected for			MH	Both	Attenuation formula has been used for years. Inside the beltline it's accepted and belived conservative, and this is probably true. Greater impact associated with harvested data outside of beltline.	
RPV - Samples from virtually any vessel	Enable measurement of both the Charpy transition curve and master curve transition temperature T0	Provides data supporting evolution from the use of correlative (Charpy-based) to direct measurement (fracture toughness-based) approaches	MH		MH		H		#N/A	embrittlement is not inspected for			MH		Very limited ex-plant data exists worldwide (perhaps 6 plants) to compare to surveillience data. Those data that do exist compare reasonably well, &/or have explainable reasons for disagreement. We have little physical reason to expect differences between ex-plant (harvested) data and surveillience data ... but (as noted) we have not checked in that many cases.	

	Basic Info		Technical Criteria										Cost / Complexity		Project Specific	
Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Criticalness of Technical Gap Addressed		Importance of Harvested Materials over Laboratory Aging		Applicability to US Operating Fleet		Regulatory Considerations Related to Inspections and AMPs		Score Average	Basis for Technical Priority			Timeliness of results	Availability of materials for harvesting
METALS			Score	Comment	Score	Comment	Score	Comment	Score	Comment			Score	Comment		
High fluence reactor internals	Void swelling, mechanical properties, IASCC	Likely extent of void swelling in PWRs during extended operation and impact on cracking	M	Fills data gap for extended plant operation	MH	Laboratory replication very difficult to impossible to achieve fluences with representative irradiation conditions	MH	Applicable to high-fluence components in most PWRs	MH	EPRI performing R&D on NDE for void swelling; MRP-227 uses primarily visual testing, which could detect void swelling once fairly significant	**3.75**	Significance of void swelling at higher fluences is uncertain, and inspections may detect onset of significant degradation	VH	Very high cost for highly irradiated internals		TBD
Higher fluence SS welds (>2 dpa)	Fracture toughness, IASCC, and microstructure	CGR and FT properties for irradiated SS weld and HAZ materials to inform inspection scope and interval and flaw evaluation	H	Little to no data exists on SS welds above 2 dpa	M	Fluence levels may be achieved by test reactor irradiation (e.g. further irradiation of Zorita welds), but would be most representative with ex-plant materials.	MH	Applicable to most PWRs	MH	MRP-227 requires visual inspections, which can be followed by volumetric to size flaws. However, lack of data above 2 dpa creates uncertainty on assumptions for CGR and FT in flaw evaluation.	**4**	Inspections are required, but lack of data above 2 dpa creates uncertainty on assumptions for CGR and FT in flaw evaluation.	H	High cost for irradiated components		
Thermally aged unirradiated CASS	Fracture toughness and microstructure	Fracture toughness data in real conditions to compare to accelerated aging data	MH	Validate accelerated aging data	H	Purpose of work would be to provide real-world validation of accelerated aging in lab testing	M	Most applicable to a subset of PWRs	H	No ISI method available to measure loss of FT	**4.25**	Would greatly increase confidence in large set of accelerated aging data with testing of unirradiated materials	M	Moderate cost for contaminated, but not irradiated, primary stsem components		
Moderate fluence (1-2 dpa) CASS	Fracture toughness and microstructure	Fracture toughness data near limit requiring further evaluation	ML	Confirm regulatory position	MH	May be possible, but difficult to replicate long-term aging and irradiation effects	M	Most applicable to a subset of PWRs	H	No ISI method available to measure loss of FT	**3.5**	Would increase confidence in regulatory position	H	High cost for irradiated components		
Metallic components with known flaws	NDE and destructive examination	Determine whether SCC mitigation methods are effective at preventing SCC; effectiveness of NDE at detection and sizing	MH	Validate NDE and mitigation method effectiveness	MH	Purpose of work would be to provide real-world validation of lab testing	H	Applicable to all plants	ML	Purpose of this work is to assess inspection and mitigation method effectiveness	**3.75**	Increase confidence in NDE and mitigation methods	M	Moderate cost for contaminated, but not irradiated, primary stsem components		
Metallic components with limiting fatigue life	NDE and destructive examination	Determine whether fatigue flaws are present in high usage locations	MH	Validate fatigue life methodologies	ML	Purpose of work would be to provide real-world validation of lab testing	H	Applicable to all plants	ML	Fatigue calculations inform sampling inspections of limiting fatigue locations	**3.25**	Increase confidence in fatigue life calculations	M	Moderate cost for contaminated, but not irradiated, primary stsem components		

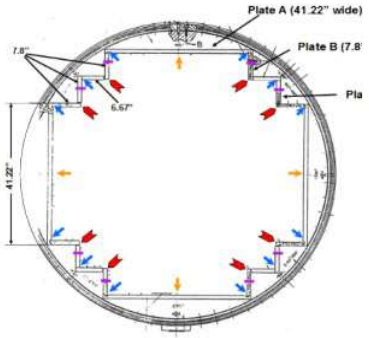
	Basic Info		Technical Criteria										Cost / Complexity		Project Specific	
Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Criticalness of Technical Gap Addressed		Importance of Harvested Materials over Laboratory Aging		Applicability to US Operating Fleet		Regulatory Considerations Related to Inspections and AMPs		Score Average	Basis for Priority			Timeliness of results	Availability of materials for harvesting
ELECTRICAL			Score	Comment	Score	Comment	Score	Comment	Score	Comment			Score	Comment		
Low and medium voltage cables																
Cables protected with fire retardant coating																
1E MOVs from harsh and mild environments																
1E Air operated valves; 4160 1E breakers																
1E Molded case breakers 480V, 250V DC, 125 VDC,																
1E Relays from mild environment GE – HFA, Agastat timing relays, any from Westinghouse, Potter Brumfield, Stuthers Dunn etc.,																
Batteries																
Electrical penetrations																
Fire research interest																
Electrical enclosures																
Distribution: switchgear, MCCs, LCs | Control: Horseshoe, SSCP, ASP, etc.																

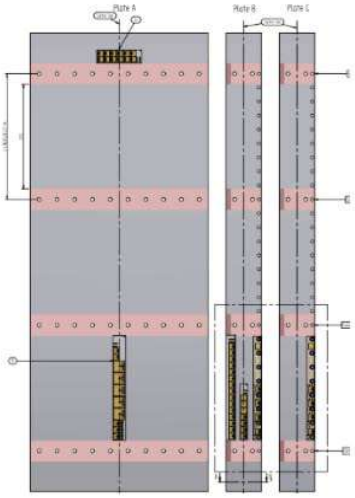
	Basic Info		Technical Criteria										Cost / Complexity		Project Specific	
Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Criticalness of Technical Gap Addressed		Importance of Harvested Materials over Laboratory Aging		Applicability to US Operating Fleet		Regulatory Considerations Related to Inspections and AMPs		Score Average	Basis for Priority			Timeliness of results	Availability of materials for harvesting
CONCRETE			Score	Comment	Score	Comment	Score	Comment	Score	Comment			Score	Comment		
Structures exposed to high radiation	Degradation of concrete due to irradiation, attenuation of radiation through concrete.	Physical and mechanical degradation data under service environment. Level of irradaiation (neutron, gamma, temperature) through the concrete and depth of irradiation damage. Aggregate expansion, cracking of concrete, differential response of components of concrete, i.e, aggregate, mortar, and rebar/steel embeds and degradation under thermo-hydro-radio-mechanical environment due to radaition. Conduct NDEs.	H	Confirm regulatory position. Data available from 1970's are not representative of light water reactor (LWR) environments. Recent limited number of data available from NRAJ are representative of LWR environment . Validate accelerated aging data. Currently no data available from service irradated concrete. Real world validation of test data and benchmarking of degradation models. Conduct NDEs.	H	Harvesting is of high importance because no data available from service irradiated concrete, inaccessible for inspection, limited lab test data, small scale lab test specimen.	M	Most PWRs	H	New aging mechanism added for further evaluation in SLR-GALL and SLR-SRP. No inspection method and data available.	4.5	Very limited data, new aging mechanism added in SLR-GALL, SLR-SRP. No inspection method and OE not available because location inaccessable. Safety significance for RPV support structures are critical.	M	Moderate cost for moderate level of irradiation on concrete.		TBD
Post-tensioned structures	Degradation of post-tensioning (PT) system.	In-situ internal degradation, delamination, adjustment of prestress force and interaction with insitu degradation.	MH	Investigate and verify knowledge related to degradation modes under sustained multi axial prestessing force without radial rebar, internal degradation, degradation of prestessing system including anchorage, NDE methods.	MH	Real world validation of lab testing, bench marking of numerical modelling, potential failure modes, applicable NDEs. Critical information from failed post-tensioned containmnet.	MH	About 37% US NPPs containment is post-tensioned. Also there are a few post-tensioned/prestressed SFP.	H	Concrete internal condition is not part of ISI. Limited condition monitoring for tendon. Detensioning and retensioning of tendons of aged containment. Effective NDE for PT containment structure not available.	4.25	Improve confidence on numerical modelling, potential failure modes, degradations, and NDEs. Collect critical information from failed post-tensioned containmnet.	L	Unirradiated		TBD
Corrosion of reinforcing steel, tendon, liner, embedment	Degradation of concrete from Alkali-Silica-Reaction (ASR)	Ongoing research is providing undersanding of the concrete material damage mechanisms and the characterization of that damage as well as of its implications to structural performance. The knowledge gained is primarily derived from laboratory testing together with visual observations of field structures.	MH	To study in-situ effects of ASR concrete degradation and comparison with understanding developed from laboratory testing. To investigate possibility of combined aging effects such as ASR and reinforcement corrosion.	M	The knowledge gained from the current research is primarily derived from controlled laboratory testing involving controlled aging environments at constant environemnts, homogeneous aging and single aging mechanism.	H	One plant severely affected by ASR in the US. Because ASR is a slow evolving chemical mechanism of the concrete itself and all plants have safety-related concrete structures, monitoring for ASR is part of concrete magement programs for all concrete structures for long term oeprations.	M	Monitoring for manifestation of ASR is part of aging management programs for concrete structures. For structures with ASR more complex aging management plans would monitor the progression of ASR, concrete cracking, structural deformations and, if needed, involve coring and testing of samples. Study of in-situ conditions would support implementation of more effective aging management plans.	3.75	Inform adjsutements to aging management programs. Enhanced understanding of the possibillity of combined degradation effects in the field. Assess homgeneity of damage in real structures.	L	Unirradiated		An international cooperative research program is being initiated under the auspices fo the CSNI. The program will test concrete samples harvested from a decommissioned nuclear power plant in Canada extensively affected by ASR. The NRC plans to participate in this program, which is likely to provide timely results

Ex-Plant Materials Harvesting Workshop

Location: NRC Headquarters in Rockville, MD, USA

Dates: March 7-8, 2017





Motivation:

- There are increasing opportunities to harvest the safety-critical components from decommissioning plants, both domestic and international.
- The harvested materials are valuable because they have been exposed to actual in-service plant operating conditions (temperature, irradiation, coolant, etc.), unlike virgin materials tested under simulated conditions in the lab.
- Data from ex-plant materials should help address technical gaps identified for extended operation of nuclear power plants due to highly relevant aging conditions.

Purpose and Objective:

- For NRC staff and interested stakeholders to have greater awareness and knowledge of the benefits and challenges associated with ex-plant harvesting.
- Facilitate contacts and communication to enable specific cooperative ex-plant harvesting programs to be initiated.

Workshop Topics:

- Harvesting decision-making and prioritization
  - Technical data needs best addressed by harvesting
  - Technical information needed in advance of harvesting
- Sources of materials:
  - Decommissioning reactors
  - Operating reactors – replaced components
  - Previous harvesting programs – “boneyards”
  - Tracking available materials
- Harvesting process
  - Lessons learned from harvesting experience
  - Perspective of utility-owner and decommissioning contractor on harvesting
  - Communication and coordination between decommissioning and researchers
- International collaborative programs on specific components at specific plants

Workshop will consist of solicited presentations followed by discussion periods. If interested in attending or learning more about the workshop, please reach out to the contacts below.

Contacts: Robert Tregoning, Robert.Tregoning@nrc.gov
Matthew Hiser, Matthew.Hiser@nrc.gov
Patrick Purtscher, Patrick.Purtscher@nrc.gov

Ex-Plant Materials Harvesting Workshop Agenda

Tuesday, March 7

Session	Time	Organization	Speaker	Presentation Title
Intro	8:00	NRC	Michael Weber Robert Tregoning	Welcome and Introduction to Workshop
1	8:15 – 8:45	DOE	Rich Reister	DOE Perspectives on Material Harvesting
		EPRI	Sherry Bernhoft	EPRI Perspective on Harvesting Projects
		NRC	Robert Tregoning	NRC Perspective on Motivation for Harvesting
		GRS	Uwe Jendrich	Role of GRS in Decommissioning and LTO
		CRIEPI	Taku Arai	CRIEPI Motivations for Harvested Material
	8:45 – 9:45	DISCUSSION		
9:45-10:00		**BREAK**		
2	10:00 – 10:20	PNNL (for NRC)	Pradeep Ramuhalli	Data Needs Best Addressed By Harvesting
	10:20 – 10:30	NRC	Matthew Hiser	High-Priority Data Needs for Harvesting
	10:30 – 10:55	DOE	Keith Leonard	LWRS Program Perspective on the Technical Needs for Harvesting
	10:55 – 11:20	SCK-CEN	Rachid Chaouadi	Review of past RPV sampling test programs and perspective for long term operation
	11:20 – 11:45	Westinghouse	Arzu Alpan	Importance of Harvesting to Evaluate Radiation Effects on Concrete Properties
	11:45 – 12:30	DISCUSSION		
12:30 – 2:00		**LUNCH**		
3	2:00 – 2:10	NRC	Matthew Hiser	Sources of Materials: Past NRC Harvesting and U.S. Decommissioning Plants
	2:10 – 2:35	EPRI	Al Ahluwalia	Harvesting Plans for Materials Aging Degradation Research in Korea and Sweden
	2:35 – 2:50	DOE/ORNL	Tom Rosseel	Materials Harvested by the LWRS Program
	2:50 – 3:00	DOE/INL	John Jackson	NSUF Material Sample Library
	3:00 – 3:15	Energy Solutions	Gerry van Noordennen	Zion Material Harvesting Program
	3:15 – 3:30	Westinghouse	Arzu Alpan	Potential Harvesting of Concrete from Mihama Unit 1
	3:30 – 3:45	**BREAK**		
	3:45 – 4:00	GRS	Uwe Jendrich	Plants in Decommissioning in Germany
	4:00 – 4:15	CNSC	Daniel Tello	Evaluating Structures, Systems & Components from Decommissioned/Decommissioning Nuclear Facilities in Canada
	4:15 – 5:00	DISCUSSION		

Wednesday, March 8

Session	Time	Organization	Speaker	Presentation Title
4	8:00 – 8:30	EPRI	Jean Smith	Lessons Learned: Harvesting and Shipping of Zorita Materials
	8:30 – 9:00	DOE	Tom Rosseel	LWRS Program: Harvesting Lessons Learned
	9:00 – 9:30	NRC	Matthew Hiser	NRC Perspective on Harvesting Experience and Lessons Learned
	9:30 – 10:00	CRIEPI	Taku Arai	CRIEPI Research Activities with Harvested Materials
	10:00 – 10:15	**BREAK**		
	10:15 - 10:45	Energy Solutions	Gerry van Noordennen	Zion Harvesting Experience and Lessons Learned
	10:45 - 11:15	Dominion	Bill Zipp	Kewaunee Insights on Material Harvesting
	11:15 – 12:00	DISCUSSION		
12:00 – 1:30		**LUNCH**		
5	1:30 – 1:45	PNNL (for NRC)	Pradeep Ramuhalli	Technical Information Needed for Informed Harvesting Decisions
	1:45 – 2:30	DISCUSSION		
	2:30 – 3:00	Action Items and Next Steps		
	3:00 – 4:00	EPRI	Sherry Bernhoft	Closing Thoughts
		DOE	Rich Reister	
		NRC	Robert Tregoning	
		ALL		

Ex-Plant Materials Harvesting Workshop

Motivation:

- There are increasing opportunities to harvest the safety-critical components from decommissioning plants, both domestic and international.
- The harvested materials are valuable because they have been exposed to actual in-service plant operating conditions (temperature, irradiation, coolant, etc.), unlike virgin materials tested under simulated conditions in the lab.
- Data from ex-plant materials should help address technical gaps identified for extended operation of nuclear power plants due to highly relevant aging conditions.

Purpose and Objective:

- For NRC staff and interested stakeholders to have greater awareness and knowledge of the benefits and challenges associated with ex-plant harvesting.
- Facilitate contacts and communication to enable specific cooperative ex-plant harvesting programs to be initiated.

Workshop Topics:

- Harvesting decision-making and prioritization
    - Technical data needs best addressed by harvesting
    - Technical information needed in advance of harvesting
- Sources of materials:
    - Decommissioning reactors
    - Operating reactors – replaced components
    - Previous harvesting programs – “boneyards”
    - Tracking available materials
- Harvesting process
    - Lessons learned from harvesting experience
    - Perspective of utility-owner and decommissioning contractor on harvesting
    - Communication and coordination between decommissioning and researchers

Workshop Approach:

- Each session will consist of solicited presentations followed by lengthy discussion and Q&A period.

HARVESTING OF AGED MATERIALS FROM OPERATING AND DECOMMISSIONING NUCLEAR POWER PLANTS

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Abstract

Recent plans to shut down a number of nuclear power plants (NPPs) provide opportunities for harvesting components that were exposed to actual light water reactor (LWR) environments. Technical issues associated with extended plant operation, such as reactor pressure vessel (RPV) embrittlement, irradiation-assisted degradation of reactor internals and primary components, concrete structures and containment degradation, and electrical cable aging, may be used to focus harvesting efforts on high-priority issues. Harvesting can provide highly representative aged materials for research and, in some cases, may be the only practical source of representative aged materials to address high-priority issues. Harvesting can be expensive and time-consuming, which makes it essential to focus on those technical needs with the highest importance and cooperate with multiple organizations whenever possible to optimally leverage resources. NRC is interested in engaging with other organizations to prioritize data needs for harvesting, identify areas of common interest, and develop a database for sources of materials for harvesting.

1. BACKGROUND

Recent developments in the nuclear industry include stronger interest in extended plant operation and plans to shut down a number of nuclear power plants (NPPs). In the U.S., there is strong interest in extending NPP lifespans through subsequent license renewal (SLR) from 60 to 80 years [1]. Further research may be required to understand age-related degradation throughout the SLR period to help ensure that aging management programs are adequate. U.S. utilities and the U.S. Nuclear Regulatory Commission (NRC) are focused on the aging of systems, structures, and components in four key technical areas: reactor pressure vessel (RPV) embrittlement, irradiation-assisted degradation (IAD) of RPV internals and primary components, concrete structures and containment degradation, and electrical cable aging [2]. In recent years, a number of NPPs, both in the U.S. and internationally, have shut down or announced plans to shut down. Unlike in the past when there were very few decommissioning plants, these plant shutdowns provide opportunities for harvesting components that were exposed to actual light water reactor (LWR) environments. Additionally, harvesting programs can be costly and complex. Given these constraints, aligning interests and leveraging with other organizations is important to allow maximum benefit and value for future research programs.

2. NRC EXPERIENCE WITH HARVESTING

NRC has significant experience with harvesting plant components and performing research on harvested materials to address technical issues. This experience includes a range of components from plants in various stages of operation both in the U.S. and internationally. Some of the harvesting projects that the NRC has participated in have studied the following materials or components:

- RPV materials from the decommissioned Gundremmingen plant to study fluence rate effects on RPV embrittlement [3],
- Cast austenitic stainless steel (CASS) materials from the decommissioned Shippingport reactor. to study CASS thermal embrittlement [4],
- RPV materials from the unfinished or never-operated Shoreham and Midland plants to improve understanding of flaw distributions for RPV embrittlement concerns [5-6],
- RPV head control rod drive mechanism penetrations from the operating North Anna and Davis-Besse plants to study primary water stress corrosion cracking (PWSCC) of nickel alloys and the effectiveness of non-destructive evaluation (NDE) methods [8-12],
- Reactor coolant system (RCS) piping nozzle weld materials from the operating V.C. Summer plant to study PWSCC of nickel alloys [11-12],

- Reactor internals materials from the decommissioned Jose Cabrera (known as Zorita) plant to study high-fluence irradiation effects on stainless steel reactor internals materials [13],
- Aluminum-based neutron-absorbing materials from the decommissioned Zion plant to study degradation in the spent fuel pool environment [14],
- Electrical cables from the decommissioned Zion and Crystal River plants to investigate cable degradation [15],
- Electrical bus ducts from the decommissioned Zion plant to study high-energy arc faults in electrical enclosures [16].

As illustrated by these programs, NRC's experience is that harvesting has contributed significantly to improved understanding of important technical issues for nuclear safety. For RPV materials, harvesting has increased knowledge of embrittlement mechanisms and the underlying flaw distributions in the RPV to allow reduction in unnecessary conservatism. For nickel alloys, harvesting has improved understanding of PWSCC and the development of acceptable inspection intervals, while also increasing confidence in the ability of NDE methods to detect and characterize flaws. Finally, recent work on electrical enclosures has helped to identify a potential new safety issue associated with high-energy arc faults in electrical components containing aluminum [16].

3. NRC PERSPECTIVE AND LESSONS LEARNED FROM HARVESTING ACTIVITIES

From NRC's perspective, a principal role of harvesting is to confirm other research results from simulated aging conditions. In many situations, accelerated aging through higher flux test reactor irradiations or elevated temperatures can be used to generate significant data to understand aging effects in a more cost-effective manner. Limited harvesting efforts of materials from actual service environments can help confirm the adequacy of the knowledge gained from accelerated aging studies, and thus increase the confidence in the broader knowledge base.

However, in certain situations, harvesting may be the only practical source of representative aged materials. For example, achieving high fluence levels with representative irradiation conditions through accelerated aging can be very challenging. Additionally, it is essential to gain as much information as possible regarding the materials and environment (temperature, fluence, irradiation conditions, chemistry, humidity, etc.) in advance before committing to a specific harvesting project so that the implications of the results from evaluating the materials can be properly understood.

Pragmatically, harvesting can be expensive, complex, and time-consuming; therefore, focusing on technical needs of high importance will help ensure good value. Likewise, leveraging and cooperation among multiple organizations helps to mitigate cost challenges. It is also quite challenging to transport irradiated materials, particularly internationally, so minimizing or avoiding transportation of irradiated materials is highly recommended.

4. NRC ACTIVITIES ON HARVESTING

NRC is potentially interested in harvesting materials to assess age-related degradation in the four technical areas identified previously: RPV embrittlement, IAD of RPV internals and primary components, concrete structures and containment degradation, and electrical cable aging [2]. The focus is to understand the impact of extended plant operation on material behavior, including the effects of higher fluences and longer exposures to aging conditions.

NRC has recently undertaken an effort, with the assistance of Pacific Northwest National Laboratory (PNNL), to develop a strategic approach for harvesting aged materials from NPPs. Past harvesting activities have been narrowly focused on the relatively few opportunities to get materials from decommissioning plants. Given the expected availability of materials from numerous plants and identified research needs to better understand aging out to 80 years of operation, the NRC is developing a more proactive approach to prioritize the data needs best addressed by harvesting and identify the best sources of materials to address high-priority data needs for regulatory research.

5. PRIORITIZATION OF DATA NEEDS BEST ADDRESSED BY HARVESTING

The first step in this strategic approach is to prioritize data needs for harvesting. A data need describes a particular degradation scenario (i.e., combination of material and environment) and should be defined with as much detail as appropriate in terms of the material (e.g., alloy, composition) and environment (e.g., temperature, fluence, chemistry).

A number of criteria are being considered for prioritizing the harvesting data needs, including:

— Applicability of harvested material for addressing critical gaps
  - Harvesting to address critical gaps should be prioritized over less essential technical gaps
— Ease of laboratory replication of the degradation scenario
  - Degradation mechanisms that are harder to replicate with simulated aging conditions would be of higher priority for harvesting. For example, simultaneous thermal and irradiation conditions are difficult to replicate outside of the plant environment. Alternatively, accelerated aging may not be feasible for a mechanism sensitive to dose rate. These two degradation mechanisms may be best evaluated using harvested materials.
— Unique field aspects of degradation
  - For example, legacy materials (e.g., fabrication methods, composition) that are no longer available, but may play an important role in a potential degradation mechanism, would have a higher priority than harvesting materials that can be obtained from other sources.
— Fleet-wide vs. plant-specific applicability of data
  - There is greater value in developing knowledge to address an issue that may be applicable to a larger number of plants compared to one that may only affect a relatively small number of plants.
— Harvesting cost and complexity
  - Activities with higher costs and complexity are less attractive than similar activities with lower costs and that are simpler to execute.. For example, harvesting unirradiated concrete or electrical cables is less expensive and less complex than harvesting from the RPV internals or the RPV.
— Availability of reliable inspection methods for the degradation scenario
  - If mature inspection methods exist and are easy to apply to monitor degradation, harvesting may be less valuable. If inspection methods do not exist, harvesting may be essential to ensure confidence in the assessment of age-related degradation in that particular component.
— Timeliness of the expected research results
  - The ability of a potential harvesting program to provide timely results to support either a technical or regulatory need is important. Having high confidence that results will be timely increases the priority.
— Availability of materials for harvesting
  - The availability of materials to harvest for a particular data need is clearly essential and increases the priority.

The above potential criteria provide a systematic approach for prioritizing harvesting data needs. Different organizations may weigh these criteria differently, but the criteria are intended to be comprehensive. NRC is interested in engaging with other organizations to further refine these criteria, use them to prioritize data needs for harvesting, and ultimately identify areas of common interest that may provide optimal harvesting opportunities.

6. DATABASE OF SOURCES OF MATERIALS FOR HARVESTING

NRC is interested in engaging with other organizations to develop a database that identifies sources of materials for harvesting. This database would include both previously harvested materials and those which may be available for future harvesting. This database would be used to align the high-priority harvesting needs to the available materials. As with the harvesting prioritization effort, the level of detail for the sources of materials database should be appropriate for the factors influencing decision-making.

7. CONCLUSIONS

NRC's experience is that harvesting can yield highly representative and valuable knowledge about materials aging. However, these efforts may be expensive and challenging. Having a clearly defined objective and early engagement with other stakeholders, including the decommissioning plant where harvesting will take place, are necessary to ensure project success. As specific harvesting opportunities are identified through this strategic approach, the NRC will develop strategies for pursuing these opportunities. The NRC also welcomes collaboration from other interested research organizations both in developing the proactive harvesting strategy and in pursuing harvesting opportunities of mutual interest.

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`Annual NRC/EPRI MOU Review Meeting – May 30, 2018

Proposed RES/DE Topics

1. Ex-Plant Materials Harvesting
    a. NRC and EPRI have cooperated effectively on several materials harvesting programs, including the reactor internals from Zorita. NRC hosted an ex-plant materials harvesting workshop in March 2017 that was attended by EPRI, DOE and international parties, which provided valuable insights and feedback on best practices and lessons learned from past harvesting efforts.
    b. NRC is prioritizing data needs for harvesting and collecting information on available sources of materials (including operating and decommissioning plants as well as previously harvested materials that we have previously used in NRC-sponsored research activities) to ensure the best value for research on harvested materials.
    c. NRC is interested in engaging with EPRI on their priorities for harvesting and how to achieve the best value in pursuing harvesting opportunities, including leveraging and cooperation.
    d. If EPRI and NRC management are aligned, informal coordination and dialogue will be pursued that could be formalized through MOU addenda or cooperative agreements for any specific research activities that result.

    ACTION: Work proactively with EPRI to identify harvesting opportunities in metals, concrete and cables to ensure the best resource leveraging. We propose developing an MOU addendum or cooperative agreement to achieve this outcome.

2. Test Reactors and Irradiated Materials Testing (New topic in response to the evolving status of the Halden Reactor)
    a. NRC is performing a strategic review of options for test reactor irradiation and irradiated materials testing capabilities, particularly in light of the potential shutdown of the Halden Reactor.
    b. NRC and EPRI cooperation on the Zorita materials research has been effective for leveraging resource-intensive testing of highly irradiated reactor internals materials.
    c. NRC is interested in further opportunities for leveraging and cooperation with EPRI for test reactor irradiation and irradiated materials testing capabilities, particularly if currently planned efforts at Halden are not able to be completed.
    d. If EPRI and NRC management are aligned, informal coordination and dialogue will be pursued that could be formalized through MOU addenda or cooperative agreements for any specific research activities that result.

    ACTION: Actively conduct contingency planning with EPRI to identify the most viable option(s) for the structural material testing that is currently planned under the Halden Research Project. A cooperative agreement or MOU addendum may be proposed to implement the most viable option identified during the planning phase.

3. Advanced Manufacturing, including Additive Manufacturing (3D printing)

    a. NRC and EPRI are separately investigating advanced manufacturing techniques that may be applied in operating reactors to produce replacement parts, or in new and advanced reactors to produce novel components.

    b. NRC hosted a public workshop on additive manufacturing (AM) in November 2017 that was attended by EPRI, DOE, and numerous other organizations. The meeting scope included standardization activities, AM research and applications in nuclear and other industries, AM processes and capabilities, and technical and regulatory challenges.

    c. EPRI staff (Dave Gandy) provided NRC with an overview of a DOE-supported demonstration project to produce a 2/3-Scale reactor pressure vessel for a small modular reactor (SMR) using advanced manufacturing with goals of reducing both cost and manufacturing cycle time. The processes employed were powder metallurgy with hot isostatic pressing (PM-HIP), electron beam welding (EBW), and diode laser cladding (DLC).

    d. NRC is interested in engaging with EPRI on addressing technical and regulatory challenges to adoption of advanced manufacturing techniques. If EPRI and NRC management are aligned, informal coordination and dialogue will be pursued that could be formalized through MOU addenda or cooperative agreements for any specific research activities that result.

    ACTION: NRC is starting to develop an agency plan (or roadmap) on AM that will identify research needs. If EPRI has plans to develop a similar roadmap, NRC would like to coordinate with EPRI to ensure that the research planned within each organization is aligned and focused on developing a sufficient technical basis to support implementation of AM within the nuclear fleet. This collaboration could be performed informally or through separate agreements or MOU addenda. It is envisioned that, once the roadmaps are developed, there may also be specific research activities that could be jointly pursued by separate agreements or an MOU addenda.

4. Application of Extended Finite Element Method (xFEM)
    a. NRC is developing a research project to explore the applicability Extended Finite Element Method (xFEM) to predict PWSCC crack growth in 3D component geometries., The xFEM technique has several advantages over conventional FEM technique, namely:
        - Mesh-independent analysis of flaws
        - SIF calculation of multiple cracks shapes without major changes to model
        - 3D crack growth without re-meshing
    b. NRC is also participating in international effort on benchmarking of xFEM capabilities. (OECD-CSNI)
    c. The ACRS FY18 biennial review report of research program recommended RES to further explore the applicability of xFEM.

    ACTION: NRC would like to engage EPRI in an effort to benchmark the xFEM application to PWSCC crack growth analyses.

Note to requester: Attachments to this email immediately follow.

From: Moyer, Carol
Sent: Thursday, May 18, 2017 12:31 PM
To: Martinez Rodriguez, Erick
Subject: Draft Talking Points for Brian Thomas for EPRI_R3.docx
Attachments: Draft Talking Points for Brian Thomas for EPRI_R3.docx; RE: Draft Notes for EPRI mtg 6/6

Hi Erick,

The attached file is a work-in-progress, in which I am collecting high level talking points for Brian Thomas for the 6/6 EPRI meeting. I am hoping to compare notes with you, in case you have received input from others. Does the level of detail seem about right? (See Raj's note, attached.)

Steve asked me to provide a draft file to Brian today, so I am working to that.

Thank you,
Carol

Draft Talking Points for Brian Thomas for EPRI-NRC Meeting (6/6/2017)

9:30 AM – Long Term Operation (LTO) Beyond 60 Years, Subsequent License Renewal

- The MOU for Long Term Operations Beyond 60 Years extends through Sept., 2021
- NRC appreciates EPRI's active participation in the April Commission briefing
- Biweekly coordination calls (EPRI/NRC/DOE) are successful

Progress and readiness for SLR applications

- As reported at the April 26th Commission briefing, NRC is ready to accept applications.
- Confirmatory research continues, to reduce uncertainty associated with key technical issues.

Public workshop on SLR topics

- At least two workshops are proposed, to include domestic and international participants.
- Fall 2018 – Focused on reactor pressure vessels, vessel internals, and piping
- Spring 2020 – Focused on concrete and electrical cable degradation
- Proposed scope of the workshops:
  - State of knowledge on the technical issues
  - Status of on-going research on materials degradation and aging management
  - New operating experience with implications for LR and SLR

Technical reports on continued adequacy of RG 1.99

- …[CIB input]
- …

Highlights of harvesting workshop

- Workshop well-attended by DOE, EPRI, NRC, US industry, and international participants. Participants discussed the motivation for harvesting, data needs best addressed by harvesting, sources of materials for harvesting and future harvesting program planning.
  - Workshop discussion emphasized the need for a clearly defined objective to justify the level of effort and demonstrate value.
  - Past harvesting experience shows valuable technical information can be gained, but harvesting efforts are expensive and complex.
- Workshop summary report will be shared among meeting participants (target: 6/30/17). Future activities from the workshop include cooperative discussion of prioritized data needs for harvesting and potential development of a sources of materials database.

Research priorities for 2017-2018

- …
- …

10:45 – Advanced Reactor Safety Research

- …
- …

IAP status

- RES/DSA is supporting IAP-2
  - Strategy 2: Acquire/develop sufficient computer codes and tools to perform non-LWR regulatory reviews
- RES/DE is supporting IAP-2 and IAP-4
  - Strategy 2: Acquire/develop sufficient computer codes and tools to perform non-LWR regulatory reviews, Functional Area – Materials and component integrity
  - Strategy 4: Facilitate industry codes and standards needed to support the non-LWR life cycle (including fuels and materials)
- …

Computational codes for non-LWRs

- …[DSA iput]
- …

Advanced manufacturing

- Advanced processes, such as additive manufacturing (3D printing), diffusion bonding, friction-stir welding, electron beam (EB) welding, and powder metallurgy (PM/HIP) have been proposed for use in new reactors.
- Benefits include reduced number of welds/joints, reduced machining waste, reduced time to manufacture, and ability to join metals that are difficult to weld conventionally.
- Some advanced manufacturing processes may introduce uncertainty.
  - Material properties need to be confirmed (e.g., PM/HIP vs. forged flanges).
  - Different inspections (pre-service and in-service) may be needed.
  - Components may be susceptible to flaw types or degradation mechanisms previously unseen in LWRs.

Gen IV materials

- RES/DE (and NRO) staff are participating in ASME B&PV Code committees working on high temperature materials needed for some advanced reactor designs.
  - Alloy 617
  - Graphite
- ASME Code is also seeking to expand the temperature range for use of some materials by supplying confirmed materials property data under a broader range of test conditions.
- NRC is collaborating with DOE-NE to avoid surprises in material selection and the establishment of technical bases for the use of newer materials and processes.
- …

11:15 – xLPR and Leak-Before-Break (LBB) Analyses

- …[CIB input]
- …

Current status of MOU development

- …
- …

2:00 – Digital Instrumentation & Control Collaboration

- …[ICEEB input]
- …

Progress during previous year

- …
- …

Priorities for 2017-2018

- …
- …

Subsequent License Renewal (SLR) Research Activities

Key Messages

- Research is being conducted by the Nuclear Regulatory Commission to confirm safe operation of nuclear power plants as they age particularly beyond the first extended operating period and into subsequent license renewal (SLR).
- Significant progress has been made in addressing the key technical issues pertinent to the aging management of systems, structures and components in nuclear power plants.
- The NRC staff continues to cooperate with the industry, Department of Energy (DOE), and Electric Power Research Institute (EPRI) to leverage research to ensure that aging effects will be adequately managed during the 60 to 80 year operating period.

Facts

- The NRC staff is performing the necessary confirmatory research to support timely and efficient reviews of future SLR applications, including the assessment of reactor structural components that could deteriorate due to material degradation resulting from extended exposure to elevated temperatures, pressures, neutron irradiation, stress, and corrosive media.
- NRC research activities will likely continue for at least 5 years in some of the technical areas, with periodic reviews to consider whether the available information is adequate to support the development of generic aging management guidance.
- Near-term confirmatory research efforts will support staff reviews of initial SLR applications.
- Longer-term confirmatory research will augment the technical basis for updating regulatory guidance in the future, as necessary, and inform staff reviews of future SLR applications.
- NRC research supports the safety basis of ongoing revisions to the aging management programs (AMPs) to ensure the functionality and safety margins of NPP systems, structures, and components (SSCs) by enhancing our understanding of the causes and how to control of degradation mechanisms.
- RES staff is collaborating with EPRI's Long-Term Operations (LTO) program and DOE's Light Water Reactor Sustainability (LWRS) staff on SLR-related research topics (reactor pressure vessel (RPV) embrittlement, irradiation-assisted damage in reactor internals, concrete degradation, and cables qualification and condition assessment).

NRC Readiness for Advanced Reactors (Non-LWRs)

Key Messages

- **The NRC can review and license new non-LWR designs using the existing regulatory framework but is working to improve processes to support effective, efficient and predictable regulatory review activities.**
- **The NRC is planning and proactively implementing activities in three focus areas to prepare for the effective, efficient and predictable review of non-LWR designs: enhancing technical readiness, optimizing regulatory readiness, and optimizing communications.**
- **In the near term (0-5 years), the NRC is focusing on technology-inclusive activities commensurate with the pace of non-LWR technology development and maturity.**

Facts

- Vendors and applicants are responsible for providing sufficient research and documentation to support their safety case, including the identification and resolution of new design issues.
- Challenges have been faced with new vendors due to limited familiarity with the regulatory process and potential vendor budget constraints. The NRC is addressing these challenges through public meetings with the vendors and various industry groups to provide information on the regulatory process and to gain insights into the challenges the vendor community is encountering or anticipating.
- The NRC and DOE have developed plans that describe their respective vision and readiness strategies to support the efficient development, licensing, and deployment of non-LWRs.
    - The NRC's vision and strategy document was issued for public comment in July 2016 and was finalized in December 2016.
    - To execute the NRCs readiness strategy, draft implementation action plans have been developed for the near-term (0-5 years), mid-term (5-10 years) and long-term (>10 years)
- The NRC is enhancing its existing regulatory framework to address non-LWRs in a technology neutral manner, which include:
    - Development of advanced, non-LWR design criteria.
    - Developing a conceptual design review process to give vendors regulatory feedback at an early design phase.
    - Developing a staged review process to allow vendors to get regulatory review at pace with their funding needs.
    - Developing prototype guidance.
- The NRC is working with DOE to implement a process for providing accurate and current information to DOE in support of the Gateway for Accelerated Innovation in Nuclear (GAIN) initiative under and MOU signed on November 10, 2016.
- The NRC is pursuing outreach activities to educate new vendors on the regulatory process. The NRC and DOE initiated the Advanced Non-LWR Workshop series to proactively reach out, educate, and interact with as many vendors and stakeholders as possible. A third workshop was held on April 25 and 26, 2017.

Non-Light Water Reactor (Non-LWR) Regulatory Framework Development

Key Messages

- **The NRC can review and license new non-LWR designs using the existing regulatory framework but is working to improve processes to support timely and efficient licensing activities.**
- **The NRC and its predecessor agency, the Atomic Energy Commission (AEC), have significant historical experience with non-LWR designs.**
- **The NRC is enhancing its existing regulatory framework to address non-LWRs in a technology neutral manner as part of its Vision and Strategy for Safely Achieving Effective and Efficient Non-Light Water Reactor Mission Readiness.**
- **The NRC is collaborating with international counterparts on regulatory approaches to non-LWRs.**

Facts

- The AEC reviewed and licensed designs dating back to the construction and operation of the first experimental breeder reactor in 1951 and the establishment of an experimental reactor program in 1954.
- The NRC has not licensed a commercial non-LWR for construction or operation, however, the NRC did review a variety of conceptual designs, at varying levels of detail, between 1978 (Hanford Fast Flux Test Reactor) and 2010 (pebble bed modular reactor (PBMR) and General Electric-Hitachi (GEH) PRISM).
- More recently, in February 2016, the NRC reviewed and approved a construction permit for a new and innovative medical isotope production facility submitted by SHINE Medical Technologies, Inc. (the "SHINE" facility). This project demonstrated the NRC's ability to review new and innovative facility designs.
- The NRC is enhancing its existing regulatory framework to address non-LWRs in a technology neutral manner as part of its Vision and Strategy for Safely Achieving Effective and Efficient Non-Light Water Reactor Mission Readiness.
- The NRC has begun hosting a series of public meetings with non-LWR stakeholders to gain feedback on various regulatory framework activities. Examples of the regulatory framework activities discussed include:
    - Developing a conceptual design review process to give vendors regulatory feedback at an early design phase.
    - Developing a staged licensing process for innovative designs within the current licensing framework.
    - Developing guidance on prototype licensing and testing.
    - In advance of the October meeting, the NRC's draft "Regulatory Review Roadmap for Non-Light Water Reactors" was released to facilitate stakeholder discussion and feedback at the meeting.
- The staff also actively participates with our international counterparts as chairs of the NEA working group on regulatory approaches to non-LWRs (focusing on sodium-cooled fast reactors) and in the IAEA Gen-IV international forum (GIF) activities.

From:	Iyengar, Raj
To:	Moyer, Carol
Cc:	Frankl, Istvan; Martinez Rodriguez, Erick
Subject:	RE: Draft Notes for EPRI mtg 6/6
Date:	Thursday, May 18, 2017 9:22:09 AM

Update from the AM meeting (per Office TA):

Talking points at a high-level (only strategy and vision) – Programmatic details could be addressed later through other exchanges.

From: Moyer, Carol
Sent: Thursday, May 18, 2017 9:15 AM
To: Iyengar, Raj <Raj.Iyengar@nrc.gov>
Cc: Frankl, Istvan <Istvan.Frankl@nrc.gov>; Martinez Rodriguez, Erick <Erick.MartinezRodriguez@nrc.gov>
Subject: RE: Draft Notes for EPRI mtg 6/6

OK, thank you, Raj.

From: Iyengar, Raj
Sent: Thursday, May 18, 2017 9:12 AM
To: Moyer, Carol <Carol.Moyer@nrc.gov>
Cc: Frankl, Istvan <Istvan.Frankl@nrc.gov>; Martinez Rodriguez, Erick <Erick.MartinezRodriguez@nrc.gov>
Subject: RE: Draft Notes for EPRI mtg 6/6

Carol,

I have a number of things to do today. I will see what I can do. CMB can provide its input to Erick. I can add to it later, if needed.

CIB staff has already developed one-pagers for RG1.99 and xLPR.

The topics on Adv. Man. And Gen IV materials come from EPRI. EPRI will be providing brief to our management on those two topics.

I have a meeting with Steve Bajorek on IAP 2. I will ask him what Mike Case wants. As you know that topics on IAPs is led by Mike Case. We can certainly provide Brian some talking points on our efforts.

Raj

From: Moyer, Carol
Sent: Wednesday, May 17, 2017 6:17 PM
To: Iyengar, Raj <Raj.Iyengar@nrc.gov>
Cc: Frankl, Istvan <Istvan.Frankl@nrc.gov>; Martinez Rodriguez, Erick <Erick.MartinezRodriguez@nrc.gov>

Subject: Draft Notes for EPRI mtg 6/6
Importance: High

Raj,

I have been drafting some notes for the EPRI-NRC management meeting on 6/6, but I don't want to duplicate your efforts on this. Can we combine what we have collected so far, and then see what is missing?

There are topics here that clearly fall within CIB's scope, e.g., RPV embrittlement (RG 1.99), and some that belong to Ian's branch. Also, I let Steve Bajorek know that I would draft some notes on Advanced Reactors, but that I would be looking to him to fill in status on the computational codes.

Steve let me know that Brian would like to see draft notes by Thursday (tomorrow), so I hope that we can discuss this in the morning.

Thanks,
Carol

_____

Carol E. Moyer
Sr. Materials Engineer
U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
MS: T-10A36
Washington, DC 20555-0001
carol.moyer@nrc.gov
301-415-2153

Note to requester: Attachments to this email immediately follow.

From: Hull, Amy
Sent: Monday, February 06, 2017 3:40 PM
To: Moyer, Carol
Cc: Frankl, Istvan (Istvan.Frankl@nrc.gov)
Subject: Carol: please review & revise, Main Take-Aways: Subsequent License Renewal Research Presentation to Bill Dean

Categories: Strategic R&D ex-plant materials

Steve suggested I talk to you about this. I will bring over a copy of his markup. I can work on this again tomorrow but must [(b)(6)] soon today.

RES-SLR-Slides-...

From: Hull, Amy
Sent: Monday, February 06, 2017 8:27 AM
To: Frankl, Istvan (Istvan.Frankl@nrc.gov) <Istvan.Frankl@nrc.gov>
Cc: Tregoning, Robert <Robert.Tregoning@nrc.gov>; Iyengar, Raj <Raj.Iyengar@nrc.gov>
Subject: please review & revise, Main Take-Aways: Subsequent License Renewal Research Presentation to Bill Dean

Brian Thomas and Raj Iyengar gave an overview of "Subsequent License Renewal Research Activities" coauthored with Amy Hull and Rob Tregoning.

Shortly after 1pm, conference room OWFN-13D20 was full. Attendees included (among others)
Bloom. Steve
Dean, Bill
Evans, Michelle

Jan 12 Key TakeAways.docx

Frankl, Steve
Hull, Amy
Iyengar, Raj
Thomas, Brian
Tregoning, Rob
Wilson, George

In response to his introduction, Bill Dean asked about what additional insights we had gained from interim AMPs (abh note, I think he was referring to LR-ISGs).

In response to the discussion on vessel internals, Bill Dean also had comments about the status of MRP-227A (which is relevant to PWR internals, AMP XI.M16A) and UT capabilities related to baffle-former bolts.

In response to the discussion on concrete degradation, Bill Dean had concern about the expense to NRC of ASR research when Seabrook is the only American NPP experiencing this problem. He wondered if this was

an appropriate use of money and wanted to know more about other ASR work, over and beyond that being done by NRC and in the USA. (Abh note, I attended several ASR sessions at SMIiRT-23 in Manchester, England and can help prepare an answer for Bill Dean).

In response to the discussion on cable qualification and condition assessment, George Wilson wanted to have a discussion about the scope of the NRC test plan. This followup discussion was held the week of January 23rd.

In response to the discussion on collaboration, Bill Dean would like to have more specific information and comparison about what various domestic and international collaborations provide to NRC.

In response to the final slide "*Look Ahead*" Bill Dean expressed most interest in the ex-plant materials harvesting workshop and wanted to make sure it also addressed cables.

General observations that were made by NRR managers included:
They want specific budget requests related to SLR research. What is the schedule of the research? What research is done? What still needs to be done? What research needs to be completed before the first SLR applications? Distinguish better between near-term and long-term research.

Bill Dean stressed that industry "must carry the water" and in conclusion asked how DE/RES would characterize the priority for further research in the four areas discussed. Rob verbally gave the following summary explaining priority for additional research in terms of technical and programmatic needs.

TOPIC	TECHNICAL	PROGRAMMATIC
Reactor Pressure Vessel Embrittlement	low	low
Vessel Internals	low	high
Concrete Degradation	medium	Low - medium
Cable Qualification and Condition Monitoring	high	high

-----Original Appointment-----
From: Dean, Bill
Sent: Friday, December 16, 2016 1:36 PM
To: Dean, Bill; Frankl, Istvan; Hull, Amy; RES_DE_Cal Resource; Bloom, Steven; Wilson, George; Marshall, Jane; Thomas, Brian; Brock, Kathryn
Subject: FW: Subsequent License Renewal Research
When: Thursday, January 12, 2017 1:00 PM-1:45 PM (UTC-05:00) Eastern Time (US & Canada).
Where: NRR-OWFN-13D20-15p

-----Original Appointment-----
From: Dean, Bill
Sent: Friday, December 16, 2016 1:31 PM
To: Dean, Bill; Bloom, Steven; Wilson, George; Marshall, Jane; Thomas, Brian; Brock, Kathryn
Subject: Subsequent License Renewal Research
When: Thursday, January 12, 2017 1:00 PM-1:45 PM (UTC-05:00) Eastern Time (US & Canada).
Where: NRR-OWFN-13D20-15p

POC: Steve x 2431

Prior to Research discussion with Glen Tracy

Brian Thomas and Raj Iyengar gave an overview of "Subsequent License Renewal Research Activities" coauthored with Amy Hull and Rob Tregoning.

Shortly after 1pm, conference room OWFN-13D20 was full. Attendees included (among others)
Bloom. Steve
Dean, Bill
Evans, Michelle
Frankl, Steve
Hull, Amy
Iyengar, Raj
Thomas, Brian
Tregoning, Rob
Wilson, George

Commented [HA1]: Please add names of other attendees, I did not document, I think Dennis Morey was there, and maybe other DLR BCs.

In response to his introduction, Bill Dean asked about what additional insights we had gained from interim AMPs (abh note, I think he was referring to LR-ISGs).

In response to the discussion on vessel internals, Bill Dean also had comments about MRP-227A (which is relevant to PWR internals, AMP XI.M16A) and UT capabilities related to baffle-former bolts.

In response to the discussion on concrete degradation, Bill Dean had concern about the expense to NRC of ASR research when Seabrook is the only American NPP experiencing this problem. He wondered if this was an appropriate use of money and wanted to know more about other ASR work, over and beyond that being done by NRC and in the USA. (Abh note, I attended several ASR sessions at SMIiRT-23 in Manchester, England and can help prepare an answer for Bill Dean).

In response to the discussion on cable qualification and condition assessment, George Wilson wanted to have a discussion about the scope of the NRC test plan. This followup discussion was held the week of January 23rd.

Commented [HA2]: Please confirm and add a couple lines if needed since I did not attend this meeting.

In response to the discussion on collaboration, Bill Dean would like to have more specific information and comparison about what various domestic and international collaborations provide to NRC.

In response to the final slide "*Look Ahead*" Bill Dean expressed most interest in the ex-plant materials harvesting workshop and wanted to make sure it also addressed cables.

General observations that were made by NRR managers included:
They want specific budget requests related to SLR research. What is the schedule of the research? What research is done? What still needs to be done? What research needs to be completed before the first SLR applications? Distinguish better between near-term and long-term research.

Bill Dean stressed that industry "must carry the water" and in conclusion asked how DE/RES would characterize the priority for further research in the four areas discussed. Rob verbally gave the following summary explaining priority for additional research in terms of technical and programmatic needs.

TOPIC	TECHNICAL	PROGRAMMATIC
Reactor Pressure Vessel Embrittlement	low	low
Vessel Internals	low	high
Concrete Degradation	medium	Low - medium
Cable Qualification and Condition Monitoring	high	high

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Subsequent License Renewal Research Activities

Briefing for

Bill Dean

Director

Office of Nuclear Reactor Regulation

January 12, 2017

Brian Thomas

Raj Iyengar **Amy Hull** **Rob Tregoning**

Outline

U.S.NRC
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Protecting People and the Environment

- **Key Messages**
- **Background:**
  - RES is addressing key technical issues and supporting the development of draft SLR Guidance Documents
- **Ongoing RES Support**
- **Collaboration & Outcomes**
- **Site Visits**
- **Look Ahead**

Key Messages

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- The key technical issues for research are as identified in Staff Requirements Memorandum (SRM) on SECY-14-0016 (August 29, 2014; ADAMS Accession No. ML14241A578)
    - reactor pressure vessel neutron embrittlement at high fluence
    - Irradiation-assisted stress corrosion cracking of reactor vessel internals
    - concrete degradation, and
    - electrical cable qualification and condition assessment

- In response to the SRM, there has been significant progress in addressing the key technical issues:
  - Accomplished through increased leverage with DOE and EPRI through "deep-dive: meetings (cables aging; concrete degradation; vessel internals; non-destructive examination (NDE) of buried pipes)

- Extensive collaboration with EPRI and DOE on SLR-related research topics

- Progress resulted in enhanced aging management programs (AMPs) addressed in the draft SLR guidance documents.

Key Messages (Continued)

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- Research objectives focused on FY2018/2019 (expected time period for initial SLR applications)
  - Continue research recognizing two periods:
    - Near-term to support review of initial SLR applications
    - Longer-term to augment the technical basis for further updates to SLR guidance

Slide Notes for Slides 3 and 4: Key Messages

SRM: "The staff should keep the Commission informed in resolving the following technical issues related to SLR reactor pressure vessel neutron embrittlement at high fluence; irradiation assisted stress corrosion cracking of reactor internals and primary system components; concrete and containment degradation, and electrical cable qualification and condition assessment."

The staff should continue to emphasize in communications with industry the need to strive for satisfactory resolution of these issues prior to the NRC beginning a review of any SLR application.

Background

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NRR-RES team effort informed the development of draft guidance documents: GALL-SLR, SRP-SLR

- RES Support to NRR (2008-2016):
  - Extended Material Degradation Assessment (EMDA) - Technical Issues
  - AMP Effectiveness Pilot Audits – Implementation/Lessons Learned
  - Assessment of International Periodic Safety Reviews (PSR) – Lessons Learned
  - Participation in Codes & Standards (ASME, ASTM, ACI, IEEE) to review/revise applicable Code Cases
- Insights/Results from Previous and Ongoing Research Activities:
  - Irradiation-assisted degradation of stainless steel plate and weld materials in RPV
  - Thermal and Neutron Embrittlement of Cast Austenitic Stainless Steels (CASS)
  - Environmentally-Assisted Fatigue of Stainless steels
  - RPV Embrittlement: Enhancement of surveillance database; Enhancement of ΔT models; ASME Code work on Master Curve Fracture Toughness
  - Containment Liner Corrosion
- Operational Experience (alkali-silica reaction (ASR), cable condition monitoring, selective leaching of buried pipes, coatings)

Background (Continued)

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NRR-RES team effort informed the development of draft guidance documents: GALL-SLR, SRP-SLR

- 97 specialized expert panels (EP) comprising of staff from NRR, RES, and the Regions for the 52 AMPs, the seven chapters containing tables of AMR line-items in NUREG-1801, and corresponding sections in NUREG-1800).
  - 37 EPs for mechanical AMPs
  - 9 EPs for structural AMPs
  - 6 EPs for electrical AMPs
  - 10 EPs for time-limited aging analyses (TLAAs)
  - 14 EPs for other SRP-LR sections
  - 18 EPs for other GALL sections and chapters (including 1521 AMR line-items)

- Expert review and comments on draft SLR guidance documents

Ongoing RES Support

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- **Research Topics:**
  - Reactor Pressure Vessel Embrittlement
  - Vessel Internals
  - Neutron Fluence Calculations
  - Concrete Degradation
  - Cable Qualification and Condition Monitoring
- **Technical Expertise**
- **Domestic and International Coordination**

Reactor Pressure Vessel Embrittlement

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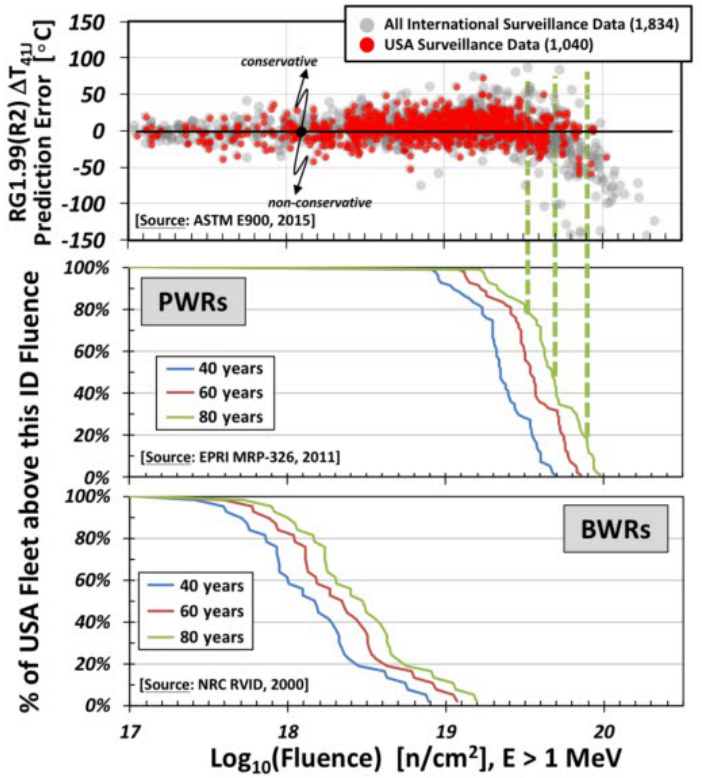
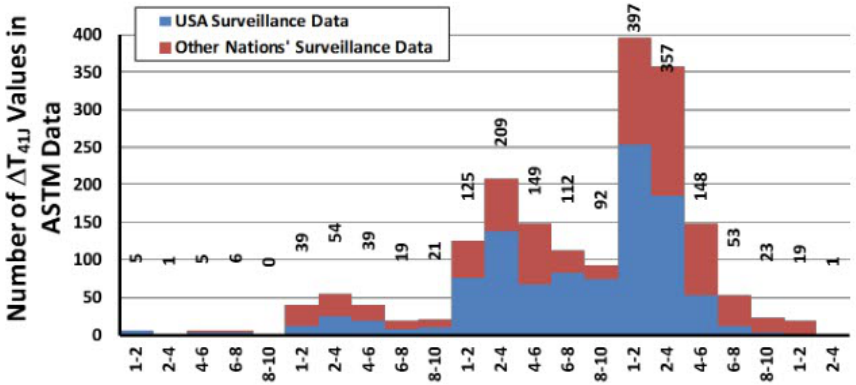
- A well-established framework of documents provides formulae to predict the evolution of the RPV's mechanical properties into SLR
- Advance evidence from surveillance programs shows that some of these formulae may need updating as irradiation continues, but this is not yet an issue for the operating fleet
- Industry programs are working to collect more data at high SLR fluence in advance of their occurrence in service
- A RES report evaluating the continued adequacy of RG1.99(R2) predictions and procedures will be prepared (ETC: 2017)
- Supports AMP XI.M31: Reactor Vessel Surveillance Capsules





Vessel Internals

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Irradiation-assisted degradation of stainless steel plate and weld materials

- NRC initiated collaborative programs with domestic and international partners:
  - International Zorita internals research project (ZIRP): Testing of ex-plant 304 SS plates (ETC: early 2017).
  - NRC-EPRI collaborative program: Testing of weld materials harvested from Zorita plant (up to 2 dpa) (ETC: 2017).
  - Halden Research Program: Further irradiation/testing of Zorita weld materials (8 dpa) (ETC: 2022).
- Research will support AMP XI.M16A: PWR Vessel Internals

Fluence (dpa)	Plate	Weld	Heat-Affected Zone
1	Previous research	Ongoing	
2			
5		Ongoing	
8			
10	Ongoing	Beyond expected fluence at 80 years (Expected fluence at 80 years)	
25			
50			
65	Planning		
80			

Testing and characterization includes crack growth rate (CGR), fracture toughness (FT), tensile properties, and microstructure (void swelling).

Cast austenitic stainless steel (CASS)

- NRC – Further testing of CASS components (3 dpa). (ETC: 2017)
- Research will support AMP XI.M12: Thermal Aging Embrittlement of CASS

Neutron Fluence Calculations

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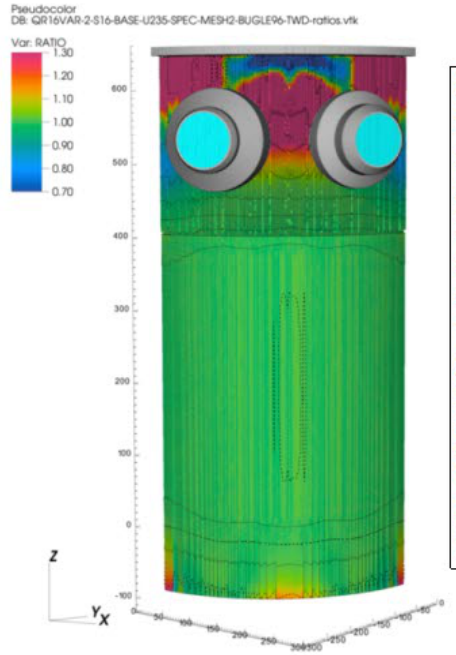
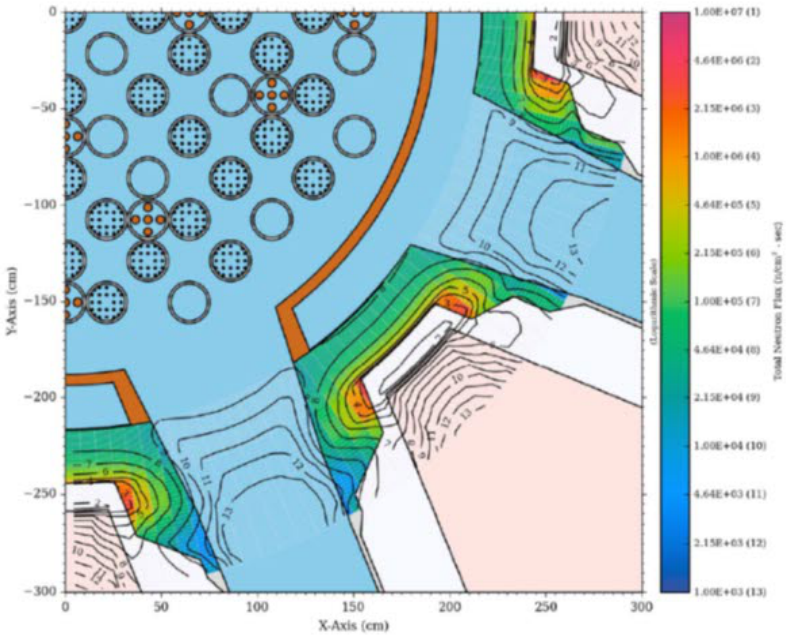
- Regulatory guide (RG) 1.190 describes acceptable methods for computing neutron flux in the RPV active core height (beltline) region
- During extended period of operations, components located outside of beltline, such as nozzles and vessel internals, experience higher levels of neutron exposure
- Research is being conducted to provide analysis of fluence at vessel locations above and below the reactor core (ETC: 2018)
- Develop technical basis for either revision to RG1.190 or new RG (will support the new AMP X.M2 on Fluence Monitoring in GALL-SLR)



Slides Notes: This image illustrates a quadrature sensitivity comparison for the baseline PWR model using a level symmetric S16 quadrature and a more accurate QR16 quadrature. There is only minor effect of quadrature on calculated flux within the beltline region (green) but large differences, up to 30%, outside of the beltline region near the nozzles (red).

Calculated ratio of neutron flux



Neutron flux near the centerline of the PWR inlet and outlet nozzles

Concrete Degradation

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Develop the technical basis for guidance to evaluate degradation of nuclear power plant concrete structures:

- Evaluate structural performance and capability to perform intended safety functions under design basis loads and accidents
- Assess aging management programs to monitor and manage aging and degradation

<u>Alkali-Silica Reaction (ASR)</u>

- NRC – Ongoing efforts at NIST on effects of ASR on concrete structural performance (ETC: early 2019), Northwestern Univ. of service life degradation (2018), and Univ. Colorado on testing/ modeling of ASR beams (ETC: 2018)
- DOE/LWRS – Ongoing efforts at Univ. Tennessee on ASR development, NDE, and structural testing (ETC: 2019)
- EPRI – Developing guidelines for ASR-affected structures (early 2018); and repair and mitigation techniques (ETC: 2018)
- Research insights/results to support the SRP-SLR Further Evaluation on ASR-affected Structures

<u>Effects of potential boric acid attack on concrete and steel in PWR spent fuel pool</u>

- EPRI - Kinetics and the extent of the attack; Role of concrete composition (ETC: 2017)

Concrete Degradation (Contd.)

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Effects of irradiation on concrete structures

- NRC :
  - Confirmatory review of DOE work on characterization of concrete irradiation damage and of EPRI research on susceptible plant configurations and their structural integrity (ETC: 2018)
  - Assessment of neutron fluence and gamma dose on the bio-shield concrete (ETC: 2018)
  - Evaluation of benefits and opportunities to harvest irradiated concrete from decommissioned plants for confirmatory testing (ETC: 2020)
- EPRI - Conducting research on integrity of concrete based on susceptible plant configuration (ETC: early-2017)
- DOE/LWRS – Modeling and prediction of damage in ASR structures (ETC: 2020)
- Research insights/results to support the SRP-SLR Further Evaluation on Irradiation Degradation of Concrete structures

Creep and creep-fracture interaction of post-tensioned containment

- NRC:
  - Review of operating experience with post-tensioned containments (loss of prestress, trend analysis of prestress forces, corrosion of prestressing systems and cracking of anchor heads) (ETC: 2019)
  - Confirmatory review (EPRI report) of creep effects on pre-stress losses and of potential for creep and fracture interactions (ETC: 2018)
- NEA/CSNI - VERCORS (EDF) – Modeling of structural behavior (ETC: 2021). {NRC participation}

Cable Qualification and Condition Assessment

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Evaluation of Condition Monitoring Techniques – Combined Gamma Radiation and Temperature Exposure

- NRC - Project with NIST & SNL to assess cable aging and evaluate monitoring techniques, such as Tan Delta (ETC: early-2019).
- DOE/LWRS (PNNL) - Project to evaluate techniques and develop models for estimating remaining useful life (ETC: mid-2019).
- EPRI - Project to assess new techniques – Dielectric Spectroscopy (ETC: late 2018).

Submergence Issues

- NRC - Reviewing EPRI report on medium voltage (MV) Kerite submergence qualification (ETC: 2017).
- EPRI - Creating a qualification program for submergence for MV shielded Okonite Okaguard insulations (ETC: 2017).
- DOE/LWRS - Published a report of potential gaps in knowledge of submerged cable degradation (ETC: 2016). Planning further research into wet cable degradation.
- EPRI & DOE - Develop lifetime prediction models incorporating uncertainties associated with accelerated aging (ETC: 2019).

Collaboration & Outcomes

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- Since July 2015, the NRC, DOE, and EPRI staff have completed a number of productive meetings under the auspices of DOE/LWRS and EPRI/LTO.
  - Addressed existing gaps, planned research activities, schedule, and expected outcomes through open and candid discussions leading to common understanding
- Deep-dive meetings:
  - Cables - October & December 2015
  - Concrete – October 2015 & April 2016
  - Vessel Internals – October 2015 & May 2016
  - RPV - October 2015
- Augmentation of DOE and EPRI research activities
  - Cable Aging and Condition Monitoring (DOE/LWRS)
  - Submergence Issues - Cables (EPRI)
  - Containment Integrity – Degradation due to Neutron Radiation (DOE; EPRI)
  - Non-Destructive Examination: Concrete Structures (DOE; EPRI); Buried Piping (DOE)

Site Visits

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- July 2015 – ORNL, Oak Ridge, TN
- April 2016 – Westinghouse Facilities, Cranberry, PA
  - Focus on RPV embrittlement, vessel internals degradation and inspection
- July 2016 – PNNL, Richland, WA
  - Focus on cables degradation research and NDE techniques
- October 2016 – AREVA Technical Center, Lynchburg, VA
  - Focus on vessel internals degradation and inspection
- April 2017 - TBD
  - Focus on concrete degradation

Look Ahead

Slide Notes: NRC/industry workshops (2018 & 2020) on status of domestic and international research activities and operating experience on long-term operations. Will address and evaluate the status of materials degradation issues in, including but not restricted to, metallic and non-metallic components, concrete structures, and cable insulation.

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- **Continued communication with DOE/LWRS and EPRI:**
  - Bi-weekly phone-calls – staff-level; Periodic management meetings
  - Roadmap/Information-Exchange meetings
- **RIC 2017:**
  - Technical session on Cables Aging and Condition Monitoring (Lead: NRR)
  - Posters on SLR guidance documents (NRR) and SLR Research Activities (RES)
- **Ex-Plant Materials Harvesting Workshop:** March 2017
  - Increase awareness of the challenges and benefits associated with ex-plant harvesting
  - Enable initiation of cooperative ex-plant harvesting programs
- **Draft User Need Request with NRR/DLR:**
  - Hold NRC/industry workshops (2018 & 2020) on status of domestic and international research activities and operating experience
  - Ensure documentation on collaborative research activities and progress
  - Develop/implement a long-term strategy for obtaining information on materials degradation (decommissioned NPPs, ex-plant components)
- **Contribute to IAEA-iGALL development and Safety Aspects of Long Term Operation of Water Moderated Reactors (SALTO) missions**

Subject: Debriefing from RIC Harvesting & AM Poster Sessions last week
Location: T10-D40, call in # 888-437-3094; passcode: [redacted] (b)(6)

Start: Thu 03/22/2018 3:30 PM
End: Thu 03/22/2018 4:00 PM
Show Time As: Tentative

Note to requester:
Attachments to this email immediately follow.

Recurrence: (none)

Meeting Status: Not yet responded

Organizer: Hull, Amy
Required Attendees: Moyer, Carol; Burke, John; Herrity, Thomas; Hiser, Matthew; Audrain, Margaret; Purtscher, Patrick; Tregoning, Robert; Harris, Brian; Frankl, Istvan

This is a followup to the info I sent you last Friday (see below). I think we got fairly good RIC response.

RIC18 Ad.Mfg. Poster visitor f...

2018 RIC poster Schedule.abh c...

draft AM Poster Feedback 2018...

RIC18 Harvesting Poster visito...

Rob suggested we get together and discuss the time we spent last week at the RIC po sters. It looks like most of you are free from 3:30-4pm today. (please propose an alternative time for us, if this does not work for you) What insights? How to improve the process for next year? What to do differently? To that end, I also include the MSW version of the forms I prepared. (it would be nice if prototypes were made available to presenters, I invented these)

Harvesting RIC18 Poster Commen...

Note to requester: The original email document had the Word file covering the words.

Steve suggested we look at how to follow up on 'actionables.' I have tried to identify and highlight these in the attached pdfs.

****

Subject: Analysis of reception of our RIC posters, thanks for your participation,

RIC poster outreach metrics parameter	AM	Harvesting
# of poster handouts taken to exhibit	75	120
# of poster handouts remaining on 3/16/2018	1	47
# posters picked up by visitors	74	73
# people noted on contact/interest/signin form	20	27
# of business cards completed, left at exhibit	13	16

completed detailed interest form	7	5

Poster staffing - 2018 RIC - March 13-15, 2018

	Tuesday		Wednesday		Thursday	
	Adv. Mfg.	Harvesting	Adv. Mfg.	Harvesting	Adv. Mfg.	Harvesting
7:30 AM	Carol	Amy	Amy	Carol	Rob	Amy
8:00 AM	Carol	Amy	Amy	Carol	Rob	Amy
8:30 AM	Carol	Meg				
9:00 AM	Carol	Meg				
9:30 AM	Amy	Meg				
10:00 AM	John	Pat	Tom	Meg	Amy	Pat
10:30 AM	Brian	Pat				
11:00 AM	Brian	Pat				
11:30 AM	Amy	Pat				
12:00 PM	Amy	Pat	Carol	Meg		
12:30 PM	Amy	Pat	Carol	Meg		
1:00 PM	John	Pat	Carol	Rob		
1:30 PM						
2:00 PM						
2:30 PM						
3:00 PM	Amy	Carol	Tom	Meg		
3:30 PM						
4:00 PM						
4:30 PM						
5:00 PM	Amy		Amy			
5:30 PM						

volunteer	Adv. Mfg. 1/2 hr sessions	Harvesting 1/2 hr sessions
Carol M.	7	3
Amy H.	10	4
J. Burke	2	
Thom Herrity	2	
Matt Hiser		
Meg Audrain		7
Pat Purtscher		8
R. Tregoning	**2**	**1**
B. Harris	2	
total	25	23
total 1/2 hr sessions	**25**	**23**

POSTER 15: AM - REACTOR MATERIALS & COMPONENTS

VISITOR NAME/ORG: _____

BUSINESS CARD: ☐ **YES** ☐ **NO** **EMAIL:**

Do you have any personal experience with AM? Is your organization researching AM? Please describe your interest in advanced or additive manufacturing (AM):

---

1. **Do you expect to implement AM in your company in the future? How so? When?**

   ☐ **Within 5 years** ☐ **5-10 years** ☐ **sometime in future** ☐ **not likely**

---

2. **Please comment on the things that stand out in your mind.**

---

3. **What should NRC be doing differently to get ready for AM implementation? Would you like NRC to have another public meeting on AM? Other suggestions?**

---

4. **Please rate the topics on a scale from 1 to 5 (5 being highest) in terms of interest:**

- AM standards &qualification [ ]
- Industry activities [ ]
- American AM activity in international context [ ]
- Cyber security [ ]
- Reverse engineering and reactor components [ ]
- Effects of process and design parameters [ ]
- Irradiation testing & effects on AM [ ]
- Nondestructive evaluation of components fabricated using AM [ ]
- Corrosion behavior of AM components [ ]
- Other areas NRC should focus on?

Please provide any other comments or feedback that may be important to NRC's review of AM for reactor materials and components.

Return to: NRC Staff at Poster 15 by Salon E By: March 15, 2018

Name **Date**

POSTER 7: HARVESTING OF AGED MATERIALS FROM NPPS

VISITOR NAME/ORG: _____

BUSINESS CARD: ☐ **YES** ☐ **NO** **EMAIL:**

Please describe your interest in harvesting components that were aged in representative light water reactor (LWR) environments in nuclear power plants (NPPs). Is your interest related to subsequent license renewal (SLR) and NPP long-term operation (LTO)?

1. **Do you expect to have harvestable components that NRC should be aware of? How so? When?**

   ☐ **Within 5 years** ☐ **5-10 years** ☐ **sometime in future** ☐ **not likely**

2. **Please comment on the things that stand out in your mind about harvesting components.**

3. **Would you like NRC to have a public meeting on harvesting NPP components? Other suggestions?**

4. **Please rate the topics on a scale from 1 to 5 (5 being highest) in terms of interest to you:**

- Reactor pressure vessel embrittlement [ ]
- Electrical cable qualification and condition assessment [ ]
- Irradiation-assisted degradation of reactor internals [ ]
- Concrete structures and containment degradation [ ]
- Availability of reliable inservice inspection (ISI) techniques [ ]
- Creating a harvesting database [ ]
- More coordination between NRC and industry on harvesting and SLR research [ ]
- Other industry activities [ ]
- Other areas NRC should focus on?

Please provide any other comments or feedback that may be important to NRC's work on harvesting of aged materials from NPPs.

Return to: NRC Staff at Poster 7 across from Salon D By: March 15, 2018

Name **Date**

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---

send email about AM articles

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WD

NRC Additive Manufacturing for Reactor Materials & Components (AM-RMC)
RIC Poster # 15, March 13-15, 2018

DAY #1

	Name	Organizational Affiliation	Email	Phone	Current AM-RMC Interest	Do you want to be on contact list?
	Don Beckman	Beckman & Assoc				
1.	Bruce Landrey	(see biz card)				
2.	Jay Fisher	Su RI	jay.fisher@suri.org	210.522.2028	MDE	✓
3.	Ludwig Huber	Alden	Lhaber@aldenlab.com		Research	✓
4.	ALEX PRATT	OKLO	ALEX@OKLO.COM			✓
5.	Rlyn Johnson	FEMA	rlyn.johnson.2@fema.dhs.gov			
6.	Hagki Youm	KETEP	hakey@ketep.re.kr	82-10-2312-5495		✓
7.	ABHIJIT SENGUPTA		ABHIJIT.SENGUPTA@DOT.GOV			✓
8.	Patricia Butler	MPR	pbutler@mpr.com		Vendor	✓

DAY #2

9.	Steve Arndt	NRC (Talk to him about Lynchburg visit)
10.	Jerry Dozier	NUS FL was doing this for replacing obsolete parts.
11.	Kazuko Sato	
12.	Allen Hiser	RAR, help put together CY18 AM meeting.
13.	Eric Focht	
14.		
15.		
16.		
17.		
18.		

NRC Additive Manufacturing for Reactor Materials & Components (AM-RMC)
RIC Poster # 15, March 13-15, 2018

	Name	Organizational Affiliation	Email	Phone	Current AM-RMC Interest	Do you want to be on contact list?
39.						
40.		SECOND DAY				
41.						
42.	Patrick Butler	MPR	(see biz card)			Y
43.	Geoff Custer	PNS	(b)(6)			
44.	Jim Kadoff	NRR				
45.	Jason Christiansen	CNS				
46.	Lili	(IRSN)	see biz card			
47.	Helge Tjoensen	"	biz card			
48.	Christopher Charles	"	biz card			
49.						
50.						
51.						
52.						
53.						
54.						
55.						

POSTER 15: AM - REACTOR MATERIALS & COMPONENTS

VISITOR NAME/ORG: RAVI JESUDA / WIRA

BUSINESS CARD: ☑ **YES** ☐ **NO** **EMAIL:**

Do you have any personal experience with AM? Is your organization researching AM? Please describe your interest in advanced or additive manufacturing (AM):

1. **Do you expect to implement AM in your company in the future? How so? When?**

   ☐ **Within 5 years** ☑ **5-10 years** ☐ **sometime in future** ☐ **not likely**

2. **Please comment on the things that stand out in your mind.**

3. **What should NRC be doing differently to get ready for AM implementation? Would you like NRC to have another public meeting on AM? Other suggestions?**

4. **Please rate the topics on a scale from 1 to 5 (5 being highest) in terms of interest:**

- AM standards &qualification [ ]
- Industry activities [ ]
- American AM activity in international context [ ]
- Cyber security [ ]
- Reverse engineering and reactor components [ ]
- Effects of process and design parameters [ ]
- Irradiation testing & effects on AM [ ]
- Nondestructive evaluation of components fabricated using AM [ ]
- Corrosion behavior of AM components [ ]
- Other areas NRC should focus on?

Please provide any other comments or feedback that is important to NRC's review of AM for reactor materials and components.

Return to: NRC Staff at Poster 15 by Salon E
Name

By: March 15, 2018
Date

POSTER 15: AM - REACTOR MATERIALS & COMPONENTS

VISITOR NAME/ORG: ALEX POPOVA/OKLO

BUSINESS CARD: ☒ **YES** ☐ **NO** **EMAIL:**

Do you have any personal experience with AM? Is your organization researching AM? Please describe your interest in advanced or additive manufacturing (AM):

---

1. **Do you expect to implement AM in your company in the future? How so? When?**

   ☒ **Within 5 years** ☐ **5-10 years** ☐ **sometime in future** ☐ **not likely**

---

2. **Please comment on the things that stand out in your mind.**

design mostly made out of metal, easy to make smaller/detailed components w/ add. manufacturing

3. **What should NRC be doing differently to get ready for AM implementation? Would you like NRC to have another public meeting on AM? Other suggestions?**

get involved w/ AM vendors, familiarize w/ process. no need for more meetings.

---

4. **Please rate the topics on a scale from 1 to 5 (5 being highest) in terms of interest:**

- AM standards &qualification [5]
- Industry activities [1]
- American AM activity in international context [ ]
- Cyber security [ ]
- Reverse engineering and reactor components [3]
- Effects of process and design parameters [4]
- Irradiation testing & effects on AM [ ]
- Nondestructive evaluation of components fabricated using AM [ ]
- Corrosion behavior of AM components [2]
- Other areas NRC should focus on?

Please provide any other comments or feedback that is important to NRC's review of AM for reactor materials and components.

Return to: NRC Staff at Poster 15 by Salon E (**Name**) By: March 15, 2018 (**Date**)

POSTER 15: AM - REACTOR MATERIALS & COMPONENTS

VISITOR NAME/ORG: JAY FISHER

BUSINESS CARD: ☑ YES ☐ NO **EMAIL:** jay.fisher@swri.org

Do you have any personal experience with AM? Is your organization researching AM? Please describe your interest in advanced or additive manufacturing (AM):

We are researching AM - how to design reliable parts + provide inspection

1. **Do you expect to implement AM in your company in the future? How so? When?**

   ☑ **Within 5 years** ☐ **5-10 years** ☐ **sometime in future** ☐ **not likely**

2. **Please comment on the things that stand out in your mind.**

   QA

3. **What should NRC be doing differently to get ready for AM implementation? Would you like NRC to have another public meeting on AM? Other suggestions?**

   Yes

4. **Please rate the topics on a scale from 1 to 5 (5 being highest) in terms of interest:**

- AM standards &qualification [2]
- Industry activities [ ]
- American AM activity in international context [ ]
- Cyber security [ ]
- Reverse engineering and reactor components [X]
- Effects of process and design parameters [3]
- Irradiation testing & effects on AM [ ]
- Nondestructive evaluation of components fabricated using AM [1]
- Corrosion behavior of AM components [UT]
- Other areas NRC should focus on?

Please provide any other comments or feedback that is important to NRC's review of AM for reactor materials and components.

Return to: NRC Staff at Poster 15 by Salon E (**Name**) By: March 15, 2018 (**Date**)

POSTER 15: AM - REACTOR MATERIALS & COMPONENTS

VISITOR NAME/ORG: Kamishan Martin / NEA

BUSINESS CARD: ☐ YES ☐ NO **EMAIL:**

Do you have any personal experience with AM? Is your organization researching AM? Please describe your interest in advanced or additive manufacturing (AM):

---

1. **Do you expect to implement AM in your company in the future? How so? When?**

   ☐ **Within 5 years** ☐ **5-10 years** ☑ **sometime in future** ☐ **not likely**

---

2. **Please comment on the things that stand out in your mind.**

---

3. **What should NRC be doing differently to get ready for AM implementation? Would you like NRC to have another public meeting on AM? Other suggestions?**

Ensuring validity of parts

4. **Please rate the topics on a scale from 1 to 5 (5 being highest) in terms of interest:**

- AM standards &qualification [ ]
- Industry activities [ ]
- American AM activity in international context [ ]
- Cyber security [4]
- Reverse engineering and reactor components [ ]
- Effects of process and design parameters [ ]
- Irradiation testing & effects on AM [ ]
- Nondestructive evaluation of components fabricated using AM [4]
- Corrosion behavior of AM components [ ]
- Other areas NRC should focus on?

Counterfeit Prevention in the Supply Chain

Please provide any other comments or feedback that is important to NRC's review of AM for reactor materials and components.

Return to: NRC Staff at Poster 15 by Salon E (**Name**) By: March 15, 2018 (**Date**)

POSTER 15: AM - REACTOR MATERIALS & COMPONENTS

VISITOR NAME/ORG: Simon Kleinbart/CUNY

BUSINESS CARD: ☒ **YES** ☐ **NO** **EMAIL:**

Do you have any personal experience with AM? Is your organization researching AM? Please describe your interest in advanced or additive manufacturing (AM):

yes - plastic rod bundle spacers for plastic

1. **Do you expect to implement AM in your company in the future? How so? When?**

   ☐ **Within 5 years** ☐ **5-10 years** ☐ **sometime in future** ☐ **not likely**

---

2. **Please comment on the things that stand out in your mind.**

porosity of 3D-printed metal parts

3. **What should NRC be doing differently to get ready for AM implementation? Would you like NRC to have another public meeting on AM? Other suggestions?**

---

4. **Please rate the topics on a scale from 1 to 5 (5 being highest) in terms of interest:**

- AM standards &qualification [5]
- Industry activities [5]
- American AM activity in international context [5]
- Cyber security [3]
- Reverse engineering and reactor components [5]
- Effects of process and design parameters [5]
- Irradiation testing & effects on AM [5]
- Nondestructive evaluation of components fabricated using AM [4]
- Corrosion behavior of AM components [5]
- Other areas NRC should focus on?

Please provide any other comments or feedback that is important to NRC's review of AM for reactor materials and components.

Return to: NRC Staff at Poster 15 by Salon E
Name

By: March 15, 2018
Date

POSTER 15: AM - REACTOR MATERIALS & COMPONENTS

VISITOR NAME/ORG: KENJI YONEBAYASHI

BUSINESS CARD: ☑ **YES** ☐ **NO** **EMAIL:** [redacted] Jnra6blue.kenji@gmail.com

Do you have any personal experience with AM? Is your organization researching AM? Please describe your interest in advanced or additive manufacturing (AM):

1. **Do you expect to implement AM in your company in the future? How so? When?**

   ☐ **Within 5 years** ☐ **5-10 years** ☑ **sometime in future** ☐ **not likely**

2. **Please comment on the things that stand out in your mind.**

   interesting

3. **What should NRC be doing differently to get ready for AM implementation? Would you like NRC to have another public meeting on AM? Other suggestions?**

4. **Please rate the topics on a scale from 1 to 5 (5 being highest) in terms of interest:**

- AM standards &qualification [5]
- Industry activities [4]
- American AM activity in international context [5]
- Cyber security [3]
- Reverse engineering and reactor components [2]
- Effects of process and design parameters [4]
- Irradiation testing & effects on AM [3]
- Nondestructive evaluation of components fabricated using AM [4]
- Corrosion behavior of AM components [4]
- Other areas NRC should focus on?

Please provide any other comments or feedback that is important to NRC's review of AM for reactor materials and components.

Return to: NRC Staff at Poster 15 by Salon E
Name

By: March 15, 2018
Date

POSTER 15: AM - REACTOR MATERIALS & COMPONENTS

VISITOR NAME/ORG: DUCOUSSO-GANJEHI

BUSINESS CARD: ☒ **YES** ☐ **NO** **EMAIL:** lili.ducousso-ganjehi@irsn.fr

Do you have any personal experience with AM? Is your organization researching AM? Please describe your interest in advanced or additive manufacturing (AM):

1. **Do you expect to implement AM in your company in the future? How so? When?**

   ☐ **Within 5 years** ☐ **5-10 years** ☐ **sometime in future** ☐ **not likely**

2. **Please comment on the things that stand out in your mind.**

   AM to reproduce manufacturing defects

3. **What should NRC be doing differently to get ready for AM implementation? Would you like NRC to have another public meeting on AM? Other suggestions?**

4. **Please rate the topics on a scale from 1 to 5 (5 being highest) in terms of interest:**

- AM standards &qualification [ ]
- Industry activities [ ]
- American AM activity in international context [ ]
- Cyber security [ ]
- Reverse engineering and reactor components [ ]
- Effects of process and design parameters [ ]
- Irradiation testing & effects on AM [ ]
- Nondestructive evaluation of components fabricated using AM ~~[ ]~~
- Corrosion behavior of AM components [ ]
- Other areas NRC should focus on?

~~NE~~ Manufacturing defects

Please provide any other comments or feedback that is important to NRC's review of AM for reactor materials and components.

Return to: NRC Staff at Poster 15 by Salon E (**Name**) By: March 15, 2018 (**Date**)

3/13/2018

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Joshua Hogancamp, Ph.D.
Postdoctoral Appointee

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HARVEST.

IRSN
INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

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NRC Harvesting of Aged Materials from NPPs * RIC Poster # 7, March 13-15, 2018

	Name	Organizational Affiliation	Email	Phone	Your Interest?	Do you want to be on contact list?
					Pentagon visit	
1.	Daniel P. Miller	Virginia Tech	millerdp@vt.edu	703-261-9621	Power plant life span - Maint Rule	Yes
2.	Noel Massie	Consultant (Westinghouse group)	nmassie625@gmail.com		Safety analysis	yes
3.	Hideo Tanaka	(see card)				
4.	Erik Slobe	University of Pittsburgh School of Law	(b)(6)			Yes
5.	Bruce Bevard	ORNL (@ Jeremy's mtg)	See business card - has Poppel's email			
6.	Maureen Koetz	Koetz & Duncan	Koetz@koetzduncan.com			
7.	Hag-ki Youm	see card				
8.	J. Hogancamp	see card			Concrete	
9.	Gareth Hopkin	see card			RPV steel/welding	
10.	Hope Alexander	PSEG Nuclear	hope.alexander@pseg.com	(b)(6)		
11.	William Zipp	Dominion see card				
12.	Ludwig Haber	Alden	Lhaber@aldenlab.com	(b)(6)	Testing	Yes
13.	F.J. Reedy, Jr.		fjreedy2@yahoo.com			Yes
14.	Bret Leslie	US NWTRB	leslie@nwtrb.gov		Aged materials	yes
15.	Jan Bens	FANC (Belgium)	jan.bens@fanc.fgov.be	210-522-	RPV	
16.	Jay Fisher	SwRI	jay.fisher@swri.org	3028	materials/NDE	yes
17.	Masa Kojima	J NRA	masayoshi_kojima@nsr.go.jp			yes
18.	Ducousso-Ganjehi	IRSN	lili.ducousso-ganjehi@irsn.fr		NDE	yes.
19.	Chris Kaplan	Bechtel	crkaplan@bechtel.com			
20.	Kyle Deming	ITTA Inc	Kdeming@itta.com			yes

NRC Harvesting of Aged Materials from NPPs * RIC Poster # 7, March 13-15, 2018

	Name	Organizational Affiliation	Email	Phone	Your Interest?	Do you want to be on contact list?
21.	Oscar Weygul	NCNR	OHW@nist.gov	301-975-6265	General	N
22.	Rich Janati	PA DEP	rjanati@pa.gov	717-787-2163	General	Y
23.	Josh Hogancamp	Sandia National Labs	jhogane@sandia.gov	615-318-5284	concrete & materials	Y
24.						
25.	Stewart Schneider					
26.	GRACE MEIKLE	CANADIAN NUCLEAR LABS	GRACE.MEIKLE@CNL.CA		offer materials to harvest	Y
27.	CHRIS CHARLES	NEI	cic@nei.org	202-739-8152		Y
28.						
29.						
30.						
31.						
32.						
33.						
34.						
35.						
36.						
37.						
38.						
39.						
40.						
41.						

POSTER 7: HARVESTING OF AGED MATERIALS FROM NPPS

VISITOR NAME/ORG: Josh Hogancamp, Sandia National Labs

BUSINESS CARD: ☒ **YES** ☐ **NO** **EMAIL:** jhoganc@sandia.gov

Please describe your interest in harvesting components that were aged in representative light water reactor (LWR) environments in nuclear power plants (NPPs). Is your interest related to subsequent license renewal (SLR) and NPP long-term operation (LTO)?

I research material aging & degradation, notably, concrete. I and my colleagues want to be on site during concrete harvesting to immediately begin measuring material properties such as time-dependent expansion, strength, etc.

1. **Do you expect to have harvestable components that NRC should be aware of? How so? When?**

☐ **Within 5 years** ☐ **5-10 years** ☐ **sometime in future** ☐ **not likely**

2. **Please comment on the things that stand out in your mind about harvesting components.**

Aged and/or irradiated concrete from NPPs is extremely hard to acquire. The material properties are extremely important for accurate simulations & predictions. I perform simulations using material data to predict issues with SLRs and NPP LTO. Accurate material data is crucial to accurate simulations.

3. **Would you like NRC to have a public meeting on harvesting NPP components? Other suggestions?**

Yes, and list possible dates for material harvesting.

4. **Please rate the topics on a scale from 1 to 5 (5 being highest) in terms of interest to you:**

- Reactor pressure vessel embrittlement [ ]
- Electrical cable qualification and condition assessment [ ]
- Irradiation-assisted degradation of reactor internals [4]
- Concrete structures and containment degradation [5]
- Availability of reliable inservice inspection (ISI) techniques [ ]
- Creating a harvesting database [4]
- More coordination between NRC and industry on harvesting and SLR research [4]
- Other industry activities [ ]
- Other areas NRC should focus on?

Please provide any other comments or feedback that may be important to NRC's work on harvesting of aged materials from NPPs.

Note to requester: This was how this page was provided to the FOIA team.

Return to: NRC Staff at Poster 7 across from Salon D
Name

By: March 15, 2018
Date

POSTER 7: HARVESTING OF AGED MATERIALS FROM NPPS

VISITOR NAME/ORG: Herb massive

BUSINESS CARD: ☑ YES ☐ NO **EMAIL:** hmassive625@gmail.com

Please describe your interest in harvesting components that were aged in representative light water reactor (LWR) environments in nuclear power plants (NPPs). Is your interest related to subsequent license renewal (SLR) and NPP long-term operation (LTO)?

SLR

1. **Do you expect to have harvestable components that NRC should be aware of? How so? When?**

   ☐ **Within 5 years** ☐ **5-10 years** ☐ **sometime in future** ☒ **not likely**

   But I know Westinghouse has

2. **Please comment on the things that stand out in your mind about harvesting components.**

   • Needed for radiation effects on aged stainless steel

3. **Would you like NRC to have a public meeting on harvesting NPP components? Other suggestions?**

   Yes, absolutely

4. **Please rate the topics on a scale from 1 to 5 (5 being highest) in terms of interest to you:**

- Reactor pressure vessel embrittlement [5]
- Electrical cable qualification and condition assessment [~~4~~]
- Irradiation-assisted degradation of reactor internals [5]
- Concrete structures and containment degradation [~~4~~]
- Availability of reliable inservice inspection (ISI) techniques [~~3~~]
- Creating a harvesting database [~~4~~]
- More coordination between NRC and industry on harvesting and SLR research [~~4~~]
- Other industry activities [ ]
- Other areas NRC should focus on?

Please provide any other comments or feedback that may be important to NRC's work on harvesting of aged materials from NPPs.

Return to: NRC Staff at Poster 7 across from Salon D (**Name**) By: March 15, 2018 (**Date**)

POSTER 7: HARVESTING OF AGED MATERIALS FROM NPPS

VISITOR NAME/ORG: Hideo Tanaka / Institute of Nuclear Safety Inc.

BUSINESS CARD: ☑ YES ☐ NO **EMAIL:** tanaka.hideo@inss.co.jp

Please describe your interest in harvesting components that were aged in representative light water reactor (LWR) environments in nuclear power plants (NPPs). Is your interest related to subsequent license renewal (SLR) and NPP long-term operation (LTO)?

1. **Do you expect to have harvestable components that NRC should be aware of? How so? When?**

   ☑ **Within 5 years** ☐ **5-10 years** ☐ **sometime in future** ☐ **not likely**

2. **Please comment on the things that stand out in your mind about harvesting components.**

   BFBs of PWR have, many Aging phenomenon.

3. **Would you like NRC to have a public meeting on harvesting NPP components? Other suggestions?**

4. **Please rate the topics on a scale from 1 to 5 (5 being highest) in terms of interest to you:**

- Reactor pressure vessel embrittlement — Reactor Supports embrittlement ✓ [ ]
- Electrical cable qualification and condition assessment [ ]
- Irradiation-assisted degradation of reactor internals [✓]
- Concrete structures and containment degradation [✓]
- Availability of reliable inservice inspection (ISI) techniques [ ]
- Creating a harvesting database [ ]
- More coordination between NRC and industry on harvesting and SLR research [✓]
- Other industry activities [ ]
- Other areas NRC should focus on?

  WWER had swelling of CI-Block. (AP1000 or ATMEA)

Please provide any other comments or feedback that may be important to NRC's work on harvesting of aged materials from NPPs.

Return to: NRC Staff at Poster 7 across from Salon D By: March 15, 2018
Name **Date**

POSTER 7: HARVESTING OF AGED MATERIALS FROM NPPS

VISITOR NAME/ORG: Daniel P. Miller / Virginia Tech

BUSINESS CARD: ☒ YES ☐ NO **EMAIL:** millerdp@vt.edu

Please describe your interest in harvesting components that were aged in representative light water reactor (LWR) environments in nuclear power plants (NPPs). Is your interest related to subsequent license renewal (SLR) and NPP long-term operation (LTO)?

-Life span of nuclear powerplants

1. **Do you expect to have harvestable components that NRC should be aware of? How so? When?**

   ☐ **Within 5 years** ☐ **5-10 years** ☐ **sometime in future** ☐ **not likely**

2. **Please comment on the things that stand out in your mind about harvesting components.** -How the data is constructed into actionable information
   -How shared? -Relationship to maint rule?
   -International coordination?

3. **Would you like NRC to have a public meeting on harvesting NPP components? Other suggestions?**

4. **Please rate the topics on a scale from 1 to 5 (5 being highest) in terms of interest to you:**

- Reactor pressure vessel embrittlement [5]
- Electrical cable qualification and condition assessment [5]
- Irradiation-assisted degradation of reactor internals [4]
- Concrete structures and containment degradation [5]
- Availability of reliable inservice inspection (ISI) techniques [5]
- Creating a harvesting database [4]
- More coordination between NRC and industry on harvesting and SLR research [4]
- Other industry activities [ ]
- Other areas NRC should focus on?

Please provide any other comments or feedback that may be important to NRC's work on harvesting of aged materials from NPPs.

Return to: NRC Staff at Poster 7 across from Salon D (**Name**) By: March 15, 2018 (**Date**)

POSTER 7: HARVESTING OF AGED MATERIALS FROM NPPS

VISITOR NAME/ORG: CANADIAN NUCLEAR LABORATORIES

BUSINESS CARD: ☐ YES ☐ NO **EMAIL:** ~~GRACEIRLE@GMAIL~~. GRACE.MEIKLE@CNL.CA

Please describe your interest in harvesting components that were aged in representative light water reactor (LWR) environments in nuclear power plants (NPPs). Is your interest related to subsequent license renewal (SLR) and NPP long-term operation (LTO)?

1. **Do you expect to have harvestable components that NRC should be aware of? How so? When?**

   ☒ **Within 5 years** ☐ **5-10 years** ☐ **sometime in future** ☐ **not likely**

2. **Please comment on the things that stand out in your mind about harvesting components.**

WE are decommissioning CNL's NRU - after 60 yrs operation. and have an extensive materials harvesting program

3. **Would you like NRC to have a public meeting on harvesting NPP components? Other suggestions?**

4. **Please rate the topics on a scale from 1 to 5 (5 being highest) in terms of interest to you:**

- Reactor pressure vessel embrittlement [ ]
- Electrical cable qualification and condition assessment [ ]
- Irradiation-assisted degradation of reactor internals [ ]
- Concrete structures and containment degradation [ ]
- Availability of reliable inservice inspection (ISI) techniques [ ]
- Creating a harvesting database [ ]
- More coordination between NRC and industry on harvesting and SLR research [ ]
- Other industry activities [ ]
- Other areas NRC should focus on?

Please provide any other comments or feedback that may be important to NRC's work on harvesting of aged materials from NPPs.

Return to: NRC Staff at Poster 7 across from Salon D (**Name**) By: March 15, 2018 (**Date**)

Note to requester: Attachment to email immediately follows. Yellow highlighted portions were in the version of the document provided to the FOIA team.

From: Purtscher, Patrick
Sent: Tuesday, May 31, 2016 7:38 AM
To: Hiser, Matthew; Iyengar, Raj; Frankl, Istvan; Hull, Amy
Cc: Tregoning, Robert
Subject: FW: 2016-NRR-UNR-Draft-May 2016 abh rev.docx
Attachments: 2016-NRR-UNR-Draft-May 2016-Enclosure-CLEAN-FINAL.DOCX

All,

I think the draft UNR is OK as is, we don't need an example in the draft at this point. The larger scale of testing was meant to cover the whole range of potential testing configuration, larger coupons to full-scale test, depending on the circumstances.

Pat

From: Hiser, Matthew
Sent: Friday, May 27, 2016 2:58 PM
To: Iyengar, Raj <Raj.Iyengar@nrc.gov>; Frankl, Istvan <Istvan.Frankl@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>; Hull, Amy <Amy.Hull@nrc.gov>
Subject: RE: 2016-NRR-UNR-Draft-May 2016 abh rev.docx

Hi,

Sorry I'm a little late to this conversation on a Friday before Memorial Day!

I agree with capturing Pat's suggestion on specimen size in Task E. I did have one edit to remove the reference to "small-scale specimens and coupons" in Task C, since the specimen size comment is being incorporated into Task E. See tracked changes in the attached.

My thoughts on this topic in general:

- Looking at K/size effects in irradiated materials is different from what I thought Pat's original proposal was for "testing of larger-scale specimens". To me, looking at K/size effects may involve repeat tests on 0.25T, 0.5T and 1T CT specimens (for example), to see the effects of specimen size and determine K validity as specimens size decreases. When Pat was describing "larger-scale testing" I thought he was envisioning full-size piping mockups or something of that nature, which is far different than varying CT specimen size. Pat, can you clarify what you are envisioning?
- For the K/size effect question, I know EPRI's Primary Systems Corrosion Research (PSCR) is already planning and sponsoring testing on the Zorita materials to look at K/size effects by testing multiple CT specimen sizes. The results from that project may at least partially address Pat's suggestion.
- For this whole discussion on what to include in the UNR regarding specimen size or large vs small-scale testing, I think it would probably be appropriate to get Rob's perspective and insight on what we need to be focusing on from his SL technical perspective.

Hope everyone has a great weekend and see you next week!

Thanks!

Matt

From: Iyengar, Raj
Sent: Friday, May 27, 2016 12:23 PM
To: Frankl, Istvan <Istvan.Frankl@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>; Hull, Amy <Amy.Hull@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>
Subject: Re: 2016-NRR-UNR-Draft-May 2016 abh rev.docx

Steve,

Sorry for confusing you. What I meant by disposition document was the deliverable under Task B. This is the disposition of EMDA issues and offering recommendations on less-resolved issues.

I am OK with the draft. No additional input from me.

Raj

From: Frankl, Istvan
Sent: Friday, May 27, 2016 12:19 PM
To: Iyengar, Raj; Purtscher, Patrick; Hull, Amy; Hiser, Matthew
Subject: RE: 2016-NRR-UNR-Draft-May 2016 abh rev.docx

Thanks, Raj.

I also like your Task E implementation of Pat's input.

You mentioned in your email below that "This will be important for the disposition document." This is why I asked question on public comments (my understanding is that the disposition document addresses these comments)

I will not send the drafts to DLR until later today. This will allow all contributors to "reflect". If you need more time, I can hold off until Monday.

Thanks,

Steve

From: Iyengar, Raj
Sent: Friday, May 27, 2016 12:18 PM
To: Purtscher, Patrick <Patrick.Purtscher@nrc.gov>; Frankl, Istvan <Istvan.Frankl@nrc.gov>; Hull, Amy <Amy.Hull@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>
Subject: Re: 2016-NRR-UNR-Draft-May 2016 abh rev.docx

Thanks, Pat.

We can pursue this further next week.

All, Have a wonderful long week and Happy Memorial Day!

Raj

From: Purtscher, Patrick
Sent: Friday, May 27, 2016 12:12 PM
To: Iyengar, Raj; Frankl, Istvan; Hull, Amy; Hiser, Matthew
Subject: RE: 2016-NRR-UNR-Draft-May 2016 abh rev.docx

I think section E is appropriate place to mention the size effects. I think one example could be the K/size criterion issue for IASCC crack growth that is discussed extensively in NUREG/CR-7027.

Pat

From: Iyengar, Raj
Sent: Friday, May 27, 2016 12:04 PM
To: Frankl, Istvan <Istvan.Frankl@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>; Hull, Amy <Amy.Hull@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>
Subject: Re: 2016-NRR-UNR-Draft-May 2016 abh rev.docx

Steve,

I have attached a revised version of the enclosure that includes some of Pat's comments. The assessment of appropriate testing is referenced in Task E.

On the "gap" of small-scale vs. large scale testing is not new. There has been ample work. But, for components experiencing IAD, there may not be a full understanding.

I do not think there was a public comment on this for GALL-SLR. But, I could be wrong.

As you had suggested, we can an internal alignment on Pat's idea and pursue it with NRR. There are at least couple of options - Task E (emergent need) from this UNR or IAD UNR. Perhaps, there are more options.

For now, I have added a phrase (highlighted) in the deliverable of Task E.

"Such issues may include, but not restricted to, providing an assessment of effect of specimen size on the prediction of component performance, technical support for aging management program audits, public meetings related to communication efforts, and confirmatory reviews of licensee submittals."

Raj

From: Frankl, Istvan
Sent: Friday, May 27, 2016 11:27 AM
To: Iyengar, Raj; Purtscher, Patrick; Hull, Amy; Hiser, Matthew
Subject: RE: 2016-NRR-UNR-Draft-May 2016 abh rev.docx

Raj,

Was this issue raised during the public comment period of the GALL-SLR or SRP-SLR?

If the identification of a gap in EMDA is new, it needs to be communicated to RES/DE management before we send specifics on it in a draft document to DLR. The EMDA is a RES deliverable, so obviously, RES/DE management should be briefed on it before we notify our counterparts in NRR. Perhaps, you or Pat could add wording to the draft that will allow us to be more specific in our response.

Any thoughts?

Steve

From: Iyengar, Raj
Sent: Friday, May 27, 2016 11:11 AM
To: Frankl, Istvan <Istvan.Frankl@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>; Hull, Amy <Amy.Hull@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>
Subject: Re: 2016-NRR-UNR-Draft-May 2016 abh rev.docx

Steve,

I just sent another approach. I realized we need to address Pat's idea soon. This will be important for the disposition document. We can also consider his idea in Task B, as part of the recommendations that we will be providing.

I will look over all of Pat's changes and incorporate them (except the one on testing) in Task C.

Raj

From: Frankl, Istvan
Sent: Friday, May 27, 2016 11:05 AM
To: Iyengar, Raj; Purtscher, Patrick; Hull, Amy; Hiser, Matthew
Subject: RE: 2016-NRR-UNR-Draft-May 2016 abh rev.docx

Raj,

I agree with your overall assessment. However, I recommend that we (and RES/DE management) should first align with Pat's recommendations and then we discuss our recommendation with DLR either during our review of their final draft (before they submit the draft UNR for NRR management review / approval), or during the drafting of the RES response.

Also, are there other revisions/changes from Pat that should be implemented in our final draft?

Thanks,

Steve

From: Iyengar, Raj
Sent: Friday, May 27, 2016 10:49 AM
To: Frankl, Istvan <Istvan.Frankl@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>; Hull, Amy <Amy.Hull@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>
Subject: Re: 2016-NRR-UNR-Draft-May 2016 abh rev.docx

Pat/Steve,

I looked into the additions proposed by Pat (highlighted in yellow). These are very valuable thoughts and should be pursued under the new UNR for IAD. I believe that is in progress.

This really does not fit the objective of developing a general database for ex-plant materials (metals, concrete and cables).

Further, these points were not vetted with DLR during our staff and management briefings on this UNR. I would prefer not to surprise them by inserting things like this, which are not directly addressing the objective.

If you still insist, I will add these to the final version.

Raj

The EMDA ranking of each aging-related degradation phenomena incorporates multiple factors that may not be adequately resolved by additional coupon testing of ex-plant materials. Part of this user need will be to examine where testing of larger-scale specimens may be appropriate to provide validation of the prediction of component performance from coupon testing.

Deliverable: RES should develop a strategic database for strategic harvesting that covers the four topical areas outlined in SRM on SECY 14-0016, which containsing information on:

- research gaps for SLR that may be best addressed by harvesting due to challenges in simulating actual service conditionsunique and significant materials aging degradation diverse sources (operating experience, other nuclear facilities, other long-lived industrial plants, other materials organizations such as ASM and NACE),
- assessment of appropriate testing program that would reduce the concern associated with the EMDA ranking,

---

From: Frankl, Istvan
Sent: Friday, May 27, 2016 10:22 AM
To: Iyengar, Raj; Purtscher, Patrick; Hull, Amy; Hiser, Matthew
Subject: RE: 2016-NRR-UNR-Draft-May 2016 abh rev.docx

Raj,

I have not yet sent the final revs to DLR, so please consider incorporating Pat's inputs into the final version (this may require copy and paste into the final rev you sent me late yesterday).

Thanks,

Steve

From: Iyengar, Raj
Sent: Friday, May 27, 2016 10:04 AM
To: Purtscher, Patrick <Patrick.Purtscher@nrc.gov>; Hull, Amy <Amy.Hull@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>
Cc: Frankl, Istvan <Istvan.Frankl@nrc.gov>
Subject: Re: 2016-NRR-UNR-Draft-May 2016 abh rev.docx

Pat,

Steve has the final version. Your points can be included in the response that we provide.

What do you think?
Raj

From: Purtscher, Patrick
Sent: Friday, May 27, 2016 9:23 AM
To: Iyengar, Raj; Hull, Amy; Hiser, Matthew
Cc: Frankl, Istvan
Subject: RE: 2016-NRR-UNR-Draft-May 2016 abh rev.docx

I added some additional comments on the harvesting to be considered.

Pat

From: Iyengar, Raj
Sent: Friday, May 20, 2016 11:15 AM
To: Hull, Amy <Amy.Hull@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>
Cc: Purtscher, Patrick <Patrick.Purtscher@nrc.gov>; Frankl, Istvan <Istvan.Frankl@nrc.gov>
Subject: RE: 2016-NRR-UNR-Draft-May 2016 abh rev.docx

Amy/Matt,

I have incorporated Matt's revisions to task c. I have also provided responses to your comments. Based on our discussion this AM. I would recommend a different UNR for the AMP audits and the strategic harvesting task (task c here), because of the longer time-frame that may be needed. Besides, these two activities may spill over beyond the receipt of first SLR application (later 2018).

This major purpose of this UNR to bring a closure to the EMDA issues, to the extent possible (and recommend further technical activities for unresolved or new emergent issues), through workshops/meetings (Task A) and through disposition documents prepared by RES staff (Task B), before the first application comes in.

Please feel free to make your final recommendations/suggestions to the comment boxes and send the document to Steve. Also feel free to add/revise language as you see fit. No need to put that on track changes.

(b)(6) [redacted] Not sure if I will be here this PM.

Thank so much for your help and support.

Raj

From: Hiser, Matthew
Sent: Thursday, May 19, 2016 8:33 PM
To: Hull, Amy <Amy.Hull@nrc.gov>; Iyengar, Raj <Raj.Iyengar@nrc.gov>
Cc: Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Subject: RE: 2016-NRR-UNR-Draft-May 2016 abh rev.docx

Hi Raj and Amy,

Please find attached (whenever this email gets to you!) my edits of the harvesting section. I am also ccing Pat Purtscher to provide any input on Task C.

Thanks!
Matt

Matthew Hiser
Materials Engineer
US Nuclear Regulatory Commission | Office of Nuclear Regulatory Research
Division of Engineering | Corrosion and Metallurgy Branch
Phone: 301-415-2454 | *Office: TWFN 10D62*
Matthew.Hiser@nrc.gov

From: Hull, Amy
Sent: Thursday, May 19, 2016 7:45 AM
To: Iyengar, Raj <Raj.Iyengar@nrc.gov>
Subject: 2016-NRR-UNR-Draft-May 2016 abh rev.docx

Raj, my two cents worth.

User Need

Evaluate the Aging Management of Systems, Structures, and Components for Subsequent License Renewal

Background:

Although the NRC staff can accept subsequent license renewal (SLR) applications now, the review would be based on guidance provided in NUREG-1800, Revision 2, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants" and NUREG-1801, Revision 2, "Generic Aging Lessons Learned (GALL) Report – Final Report." Because this guidance applies to plants operating from 40-60 years, additional review would be needed to ensure that the applicant addressed issues anticipated during 60-80 years of plant operation for SLR. Such reviews would be longer and more resource-intensive. To improve the efficiency of SLR application reviews, the NRC staff has undertaken several activities to revise the guidance documents. These activities include reviews of aging management practices, plant audits, technical information exchanges with industry and Department of Energy (DOE), and confirmatory research.

In cooperation with the DOE Light Water Reactor Sustainability (LWRS) Program, the NRC completed NUREG/CR-7153, "Expanded Materials Degradation Assessment (EMDA), Vol. 1-5" (ADAMS Accession Nos. ML14279A321, ML14279A331, ML14279A349, ML14279A430, ML14279A461) to identify the most significant technical issues for nuclear power reactor operation beyond 60 years. The EMDA ranked the significance, current knowledge, and uncertainty associated with aging-related degradation phenomena that could affect systems, structures, and components (SSCs) over 80 years of operation. As outlined in the staff requirements memorandum (SRM) on SECY 14-0016, the major technical issue areas are:

- Reactor pressure vessel neutron embrittlement at high fluence;
- Irradiation-assisted stress corrosion cracking of reactor internals and primary system components;
- Concrete and containment degradation; and
- Electrical cable qualification and condition assessment.

The NRC staff conducted several audits to investigate the effectiveness of aging management programs (AMPs). The findings are documented in the report titled, "Summary of Aging Management Program Effectiveness Audits to Inform Subsequent License Renewal: R.E. Ginna Nuclear Power Plant and Nine Mile Point Nuclear Station, Unit 1" (ML13122A007). The development of SLR guidance was based on NUREG-1800 and NUREG-1801, the understanding gained from the audits, NUREG/CR-7153 (EMDA), an evaluation of domestic and international operating experience of nuclear plants, lessons learned from staff review of previous license renewal applications, and assessment of recent research findings. Draft SLR guidance documents were issued in December 2015, as draft "Generic Aging Lessons Learned for Subsequent License Renewal (GALL-SLR) Report," (NUREG-2191, Volumes 1 and 2) and draft "Standard Review Plan for Review of Subsequent License Renewal Applications for Nuclear Power Plants" (SRP-SLR) (NUREG-2192).

Since the draft guidance documents were issued, the staff has held several public meetings with stakeholders and the public to discuss the proposed revisions and bases for the revisions. The most recent meetings were held on January 21 and February 19, 2016. Going forward, the NRC staff will continue to lead outreach activities to stakeholders and the public in order to

provide information on the proposed changes to the guidance documents, solicit feedback on the documents, and revise the documents, as appropriate, to reflect stakeholder and public feedback. The final guidance documents are expected to be issued in mid-2017.

To support the review of an SLR application, an applicant will need to demonstrate how the effects of aging will be managed, including those associated with the technical issues listed above. Although the industry is conducting research to address these major technical issues for SLR, not all the research will be completed before the first application is submitted. For those issues that the industry has not yet developed a generic technical basis to support its resolution, the NRC will request applicants to address the technical issues with plant-specific programs in their SLR applications. The staff will review these plant-specific programs that address the SLR technical issues, but anticipates a longer application review process in these cases.

The requested research described below would provide information to support the staff in effectively evaluating AMPs and developing staff positions on the technical issues identified in EMDA reports. This effort will also augment the staff's preparedness for the evaluation of the feasibility of future applications for an SLR period. These requested products should build upon analysis methods, tools, and expertise developed as part of ongoing research activities and new research activities focused specifically on aging effects during an SLR period.

Description of Scope and Tasks

A. Hold NRC/industry workshop(s) on status of domestic and international research activities and operating experience to address and evaluate the status of materials degradation issues identified in the EMDA reports for SLR.

Technical Need: In February 2008, the NRC and DOE first co-sponsored a "Workshop on U.S. Nuclear Power Plant Life Extension Research and Development" (ADAMS Accession Number ML080570419), which requested stakeholder input into aging management research areas for "Life Beyond 60." Since then, there have been multiple workshops/meetings on the research activities and operating experience that may impact aging management of SSCs for an SLR period. These meetings have been helpful in facilitating technical discussions, disseminating knowledge and information, enabling the understanding of technical challenges, and paving the path forward for resolution of the challenges and issues related to materials degradation during the SLR period. As the NRC staff prepares for the review of SLR applications, there is a need for continued engagement with domestic industry, DOE and other federal organizations, academia, international partners, and interested public stakeholders through workshops focused on the status and resolution of major technical issues outlined in the SRM and identified in EMDA.

Deliverable: RES staff should facilitate several workshops/meetings on operating experience from the initial license renewal period, research results on materials degradation issues, and aging management of SSCs during the SLR period.

These meetings should be specifically targeted toward the resolution of technical issues for effective aging management of SSCs during the SLR period. RES staff should provide an annual technical letter report summarizing the understanding gained through the workshops/meetings. The summary should include the status of domestic and international research activities in addressing materials degradation issues and aging management practices during the SLR period. The report should also discuss (1) areas of progress and issues resolution, (2) areas of insufficient progress that may warrant additional NRC-driven

interactions, and (3) any newly identified technical issues that should be considered.

Schedule: The effort should last no more than 36 months from the period of inception of this user need request.

B. Provide RES staff assessments of the current knowledge and disposition of materials degradation issues identified in the EMDA reports

Technical Need: As mentioned earlier, the EMDA reports identified significant technical issues for nuclear power reactor operations beyond 60 years related to materials degradation. These issues fall under the following four topical areas, as outlined in SRM on SECY 14-0016:

- Reactor pressure vessel neutron embrittlement at high fluence;
- Irradiation-assisted stress corrosion cracking of reactor internals and primary system components;
- Concrete and containment degradation; and
- Electrical cable qualification and condition assessment.

The NRC, DOE, and industry are addressing the key technical issues related to materials degradation at NPPs. In order to gain better understanding of the materials aging and degradation mechanisms and their implications of structural and component integrity, DOE and the industry have initiated numerous research activities on the four major technical areas. The NRC staff conducts confirmatory research, through several user need requests on specific technical issues, to independently verify licensee data, determine safety margins, and explore uncertainties. In addition, the NRC research will support and increase the efficiency of staff review of SLR applications. To fully support the staff review of the SLR applications, RES should develop staff assessments of the current knowledge and disposition of materials degradation issues related to the four major technical areas. The assessments should also include recommendations on the need for:

- any interim staff guidance (ISG) to address aging management issues, and
- new regulatory guidance and/or revision of existing regulatory guides (RGs) to address uncertainties in knowledge and/or potential non-conservativism.

Deliverable: Deliver a technical letter report that summarizes the current knowledge and disposition of materials degradation issues identified in EMDA. The report should also include recommendations on the need for any new or revised guidance to address component integrity of aging structures.

Schedule: The effort should last no more than 36 months from the period of inception of this user need request. The initial draft report should be completed by the end of FY 2018.

C. Develop and implement a long-term strategy for obtaining information on materials degradation from decommissioned NPPs, as well as from ex-plant components from operating plants.

Technical Need: The NRC performs confirmatory research to inform and develop the technical basis for regulatory decisions related to aging management programs for

SLR. Historically, this research has included testing ~~small-scale specimens or coupons on~~ virgin materials under simulated aging conditions, as well as testing and characterization of ex-plant materials harvested from nuclear power plants. Ex-plant materials are valuable because they have been exposed to actual in-service plant operating conditions (temperature, irradiation, coolant, etc.), unlike virgin materials tested under simulated conditions in the lab. Testing ex-plant materials also reduces the uncertainty associated with the applicability of the aging conditions. Therefore, this effort is expected to provide fundamental insights on reactor materials degradation and information addressing potential
technical issues or identified gaps to support anticipated future NRC needs. It will also inform the value of existing databases based on simulated aging conditions by assessing their applicability to in-service conditions.

Based on the recent experience of recovering materials from decommissioned plants, such as Zion, Crystal River and Zorita (Spain), the efforts of planning, coordination and eventual harvesting of these materials could be resource-intensive and time-challenging. Future efforts to retrieve materials from decommissioned plants should be focused on the highest value SSCs by proactively developing a strategic database for obtaining unique and significant materials aging degradation information from ex-plant components. Such a database will enable the NRC to focus its harvesting efforts and expeditiously obtain materials and components from plants to be decommissioned in the near future and develop information and knowledge to assess the efficacy of the AMPs.

Deliverable: RES should develop a database covering the four topical areas outlined in SRM on SECY 14-0016 and containing information on:

- research gaps for SLR that may be best addressed by harvesting due to challenges in simulating actual service conditions, and
- materials that can be harvested from to-be-decommissioned NPPs and ex-plant components from operating plants to better inform the NRC's AMPs and aging-related regulatory oversight and to better plan research activities.

RES should deliver periodic reports assessing the effectiveness of such programs and recommending any improvements for the SLR period.

Schedule: The effort should last no more than 36 months from the period of inception of this user need request.

D. Continue to Develop Domestic and International Partnerships to Share Expertise, Capabilities and Resources Related to Aging Management Research for Long-Term Operations (LTO)

Technical Need: Various domestic and foreign research organizations, government agencies, utilities and research organizations are presently engaged in aging management research, the results of which may be of value to the NRC regarding plant operations during the SLR period. Additionally, the Electric Power Research Institute (EPRI) is engaged with various international research organizations to develop data on aging mechanisms/effects. As such, it benefits the NRC to be engaged in domestic and international research partnerships in order to evaluate all available operating experience and relevant research, leverage resources and minimize unnecessary

duplication of efforts. It would be advantageous to the NRC to develop partnerships with these entities such that the various research programs could be better coordinated and focused on high-priority needs.

Deliverable: Continue to develop agreements with domestic and international partners to collaborate on aging management research that results in information to help inform agency decisions regarding SLR and long-term operations. Integrate as appropriate the results of these collaborative research and information exchanges from international partnerships into Tasks A and B. Provide an annual summary of international collaborative research results and status of interactions (e.g., references to meeting minutes, presentations, technical reports, etc.), highlighting international activities and results that may affect SLR.

Schedule: The effort should continue until the closure of this user need request.

E. **Provide technical assistance, as needed, for preparation of review of SLR applications.**

Technical Need: As the NRR staff prepares for the anticipated SLR application in FY18, technical assistance from RES staff on emergent issues may be needed. Such issues may include, but not restricted to, providing an assessment of effect of specimen size on the prediction of component performance, technical support for aging management program audits, public meetings related to communication efforts, and confirmatory reviews of licensee submittals.

Schedule: This effort, as needed, should continue until the closure of this user need request.

From: Moyer, Carol
Sent: Wednesday, November 30, 2016 10:02 AM
To: Hiser, Matthew
Subject: FW: 42 NUSSC Day 1

FYI, Kathryn plugged your workshop in Vienna this week.

From: Thomas, Brian
Sent: Wednesday, November 30, 2016 9:58 AM
To: Brock, Kathryn <Kathryn.Brock@nrc.gov>; Weber, Michael <Michael.Weber@nrc.gov>; Hackett, Edwin <Edwin.Hackett@nrc.gov>
Cc: Coffin, Stephanie <Stephanie.Coffin@nrc.gov>; Tappert, John <John.Tappert@nrc.gov>; Abu-Eid, Boby <Boby.Abu-Eid@nrc.gov>; Collins, Daniel <Daniel.Collins@nrc.gov>; Moyer, Carol <Carol.Moyer@nrc.gov>; Layton, Michael <Michael.Layton@nrc.gov>; Pstrak, David <David.Pstrak@nrc.gov>
Subject: RE: 42 NUSSC Day 1

Thanks Kathryn. Good plug for our research sessions at the RIC and for opportunities to further our collaboration on research.

From: Brock, Kathryn
Sent: Wednesday, November 30, 2016 3:07 AM
To: Thomas, Brian <Brian.Thomas@nrc.gov>; Weber, Michael <Michael.Weber@nrc.gov>; Hackett, Edwin <Edwin.Hackett@nrc.gov>
Cc: Coffin, Stephanie <Stephanie.Coffin@nrc.gov>; Tappert, John <John.Tappert@nrc.gov>; Abu-Eid, Boby <Boby.Abu-Eid@nrc.gov>; Collins, Daniel <Daniel.Collins@nrc.gov>; Moyer, Carol <Carol.Moyer@nrc.gov>; Layton, Michael <Michael.Layton@nrc.gov>; Pstrak, David <David.Pstrak@nrc.gov>
Subject: 42 NUSSC Day 1

Hello. 42 NUSSC kicked off in the afternoon, so we are really just getting started. The afternoon was spent discussing general business, with a welcome from Greg Rzentkowski (Director NSNI). Greg gave us a summary of the Senior Regulators Meeting including a discussion on the focus on safety/security interface, regulatory readiness, and the concept of strength in depth. NUSSC Chair Fabien Feron gave a summary of the CSS meeting, which was consistent with the information provided by Michele Sampson. Fabien spoke of the need to have a common standards development process, a common glossary, and a holistic review of the complete collection of safety guides. More to come on those topics, I'm sure.

There was another demonstration of the IT Platform, NSS-OUI, and a thank you to the USA and Japan for supporting the tool development. I expressed my support of the tool and that we are starting to use it more. Another exciting IT discussion was related to the possibility of remote access to the standards meetings. I believe this was piloted by EPReSC and RASSC, so I will follow up with my colleagues. This may be helpful to us if we choose to have a support staff member participate in the meetings from DC - it gives the option of reducing travel costs on a second traveler and it gives the opportunity for others to hear the standards committees in action.

In the morning I had a follow up meeting with Ed Bradley and several Directors responsible for research in fuel cycle, waste technology, materials, reactors, and knowledge management. These folks are excited about

potential collaborative efforts with NRC and will be providing us some specific areas to consider where research collaboration may be possible. I told them about the RIC and the March meeting on harvesting of ex-plant material for research purposes. They were excited to hear about the RIC, especially the sessions on leveraging international research.

That's all for now. Enjoy your day.

Kathy

Subject:	Ex-Plant Materials Harvesting Workshop
Location:	HQ-TWFN-P2AUD-300p
Start:	Tue 03/07/2017 7:00 AM
End:	Tue 03/07/2017 6:00 PM
Show Time As:	Tentative
Recurrence:	(none)
Meeting Status:	Not yet responded
Organizer:	Hiser, Matthew
Resources:	HQ-TWFN-P2AUD-300p

Reserving as placeholder for workshop.

Subject:	Ex-plant Materials Harvesting Workshop
Location:	HQ-TWFN-P2AUD-300p
Start:	Thu 03/16/2017 1:00 PM
End:	Thu 03/16/2017 7:00 PM
Show Time As:	Tentative
Recurrence:	(none)
Meeting Status:	Not yet responded
Organizer:	Hiser, Matthew
Resources:	HQ-TWFN-P2AUD-300p

Reserving as placeholder for workshop around RIC.

Subject:	Ex-plant Materials Harvesting Workshop
Location:	HQ-TWFN-P2AUD-300p
Start:	Fri 03/17/2017 7:00 AM
End:	Fri 03/17/2017 6:00 PM
Show Time As:	Tentative
Recurrence:	(none)
Meeting Status:	Not yet responded
Organizer:	Hiser, Matthew
Resources:	HQ-TWFN-P2AUD-300p

Reserving as placeholder for workshop around RIC.

Subject:	Ex-Plant Materials Harvesting Workshop
Location:	HQ-TWFN-P2AUD-300p
Start:	Wed 03/08/2017 7:00 AM
End:	Wed 03/08/2017 6:00 PM
Show Time As:	Tentative
Recurrence:	(none)
Meeting Status:	Not yet responded
Organizer:	Hiser, Matthew
Resources:	HQ-TWFN-P2AUD-300p

Reserving as placeholder for workshop.

From: Hiser, Matthew
Sent: Wednesday, September 14, 2016 3:01 PM
To: Vera, Graciela
Subject: Ex-plant Materials Harvesting

Hi Gracie,

Could you schedule a briefing with Brian Thomas on Ex-Plant Materials Harvesting? Please include the following participants:

Brock, Kathryn
Tregoning, Robert
Thomas, Brian
Purtscher, Patrick
Frankl, Istvan

It looks like there are available times on September 27 or 28.

Thanks!
Matt

Matthew Hiser
Materials Engineer
US Nuclear Regulatory Commission | Office of Nuclear Regulatory Research
Division of Engineering | Corrosion and Metallurgy Branch
Phone: 301-415-2454 | *Office: TWFN 10D62*
Matthew.Hiser@nrc.gov

From: Hull, Amy
Sent: Wednesday, September 02, 2015 2:22 PM
To: Iyengar, Raj; Hiser, Matthew
Subject: cross-cutting topic...: Specific Questions for Internals and Piping Materials for Deep-dive meetings

...I will have to do that tomorrow morning. I have to leave in 10 minutes for another meeting.

From: Hull, Amy
Sent: Wednesday, September 02, 2015 8:22 AM
To: Iyengar, Raj <Raj.Iyengar@nrc.gov>; Tregoning, Robert <Robert.Tregoning@nrc.gov>; Rao, Appajosula <Appajosula.Rao@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>
Cc: Frankl, Istvan <Istvan.Frankl@nrc.gov>; Prokofiev, Iouri <Iouri.Prokofiev@nrc.gov>
Subject: RE: Specific Questions for Internals and Piping Materials for Deep-dive meetings

I am making 2 changes this morning

(1) Adding a cross-cutting line to account for discussions we need to have with EPRI, LWRS, and NEI concerning our new work on prioritization of strategic harvesting opportunities. This is a followup from the Materials TIE presentation Matt H and I made a few months ago in which industry people said they were interested in participating.
(2) revised line for Ni alloy DMWs in BMI (followup from AMP Effectiveness Audit at Ginna and SLR SME panel discussions for AMP XI.M11B on NI alloys) - this is Iouri's contribution that he talked to Raj about

From: Iyengar, Raj
Sent: Tuesday, September 01, 2015 10:46 PM
To: Tregoning, Robert <Robert.Tregoning@nrc.gov>; Hull, Amy <Amy.Hull@nrc.gov>; Rao, Appajosula <Appajosula.Rao@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>
Cc: Frankl, Istvan <Istvan.Frankl@nrc.gov>
Subject: Specific Questions for Internals and Piping Materials for Deep-dive meetings

All,

Please review the word document on the specific questions related to internals and piping materials. Rob expressed an interest in meeting with you all to seek alignment on the questions. Because I will not be in before Noon tomorrow, please go ahead with the meeting (Perhaps, one of you could schedule the meeting for tomorrow AM). If not, we can meet after 1 PM tomorrow.

I have included only those sub-issues that require a deep-dive meeting. I have not included sub-issues related to Alloy 600/690, and the CS - BAC sub-issue. If I have missed any, please let me know. I need to get questions from DLR (at least on the leaching issue).

I believe BT/KB would like to see these questions tomorrow PM. We have already settled down on the questions related to Cables and Concrete. This is the last major issue that would warrant a deep-dive meeting.

I have also attached the table (with Rob's edits).

Thanks a lot for your willingness to put up with me.

Raj

Subject:	Ex-Plant Harvesting Coordination Meeting
Location:	HQ-TWFN-10A73-8p
Start:	Mon 11/20/2017 10:30 AM
End:	Mon 11/20/2017 11:30 AM
Show Time As:	Tentative
Recurrence:	Weekly
Recurrence Pattern:	every 2 week(s) on Thursday from 2:30 PM to 3:30 PM
Meeting Status:	Not yet responded
Organizer:	Hiser, Matthew
Required Attendees:	Purtscher, Patrick; Audrain, Margaret; Tregoning, Robert
Resources:	HQ-TWFN-10A73-8p

Rescheduling for Monday so we can all attend.

Setting up a standing every other week meeting on harvesting to help us stay on track and keep making progress.

Topics:

- Sources of Materials
- Prioritization of Data Needs
- PNNL TLR

Subject:	Ex-Plant Harvesting Coordination Meeting
Location:	10th floor huddle
Start:	Thu 12/07/2017 10:30 AM
End:	Thu 12/07/2017 11:30 AM
Show Time As:	Tentative
Recurrence:	Weekly
Recurrence Pattern:	every 2 week(s) on Thursday from 2:30 PM to 3:30 PM
Meeting Status:	Not yet responded
Organizer:	Hiser, Matthew
Required Attendees:	Purtscher, Patrick; Audrain, Margaret; Tregoning, Robert

Setting up a standing every other week meeting on harvesting to help us stay on track and keep making progress.

Topics:

- Sources of Materials
- Prioritization of Data Needs
- PNNL TLR

Subject:	Ex-Plant Harvesting Coordination Meeting
Location:	10th floor huddle
Start:	Mon 12/11/2017 1:00 PM
End:	Mon 12/11/2017 2:00 PM
Show Time As:	Tentative
Recurrence:	Weekly
Recurrence Pattern:	every 2 week(s) on Thursday from 2:30 PM to 3:30 PM
Meeting Status:	Not yet responded
Organizer:	Hiser, Matthew
Required Attendees:	Purtscher, Patrick; Audrain, Margaret

Setting up a standing every other week meeting on harvesting to help us stay on track and keep making progress.

Topics:

- Sources of Materials
- Prioritization of Data Needs
- PNNL TLR

Subject:	Ex-Plant Harvesting Coordination Meeting
Location:	HQ-TWFN-10A73-8p
Start:	Tue 01/09/2018 2:00 PM
End:	Tue 01/09/2018 3:00 PM
Show Time As:	Tentative
Recurrence:	Weekly
Recurrence Pattern:	every 2 week(s) on Thursday from 2:30 PM to 3:30 PM
Meeting Status:	Not yet responded
Organizer:	Hiser, Matthew
Required Attendees:	Purtscher, Patrick; Audrain, Margaret; Tregoning, Robert
Resources:	HQ-TWFN-10A73-8p

Setting up a standing every other week meeting on harvesting to help us stay on track and keep making progress.

Topics:

- Sources of Materials
- Prioritization of Data Needs
- PNNL TLR

Subject:	Ex-Plant Harvesting
Location:	10th floor huddle room
Start:	Thu 08/18/2016 11:00 AM
End:	Thu 08/18/2016 11:30 AM
Show Time As:	Tentative
Recurrence:	(none)
Meeting Status:	Not yet responded
Organizer:	Hiser, Matthew
Required Attendees:	Frankl, Istvan; Tregoning, Robert; Purtscher, Patrick

I think it would be good to get everyone on same page regarding next steps for the harvesting program.

We have an early draft of the PNNL deliverable, with the final version expected in early 2017. I'd like to discuss that work as well as the workshop that was discussed with NRAJ last week and been discussed previously.

Thanks!
Matt

From: Iyengar, Raj
Sent: Thursday, May 18, 2017 9:22 AM
To: Moyer, Carol
Cc: Frankl, Istvan; Martinez Rodriguez, Erick
Subject: RE: Draft Notes for EPRI mtg 6/6

Update from the AM meeting (per Office TA):

Talking points at a high-level (only strategy and vision) – Programmatic details could be addressed later through other exchanges.

From: Moyer, Carol
Sent: Thursday, May 18, 2017 9:15 AM
To: Iyengar, Raj <Raj.Iyengar@nrc.gov>
Cc: Frankl, Istvan <Istvan.Frankl@nrc.gov>; Martinez Rodriguez, Erick <Erick.MartinezRodriguez@nrc.gov>
Subject: RE: Draft Notes for EPRI mtg 6/6

OK, thank you, Raj.

From: Iyengar, Raj
Sent: Thursday, May 18, 2017 9:12 AM
To: Moyer, Carol <Carol.Moyer@nrc.gov>
Cc: Frankl, Istvan <Istvan.Frankl@nrc.gov>; Martinez Rodriguez, Erick <Erick.MartinezRodriguez@nrc.gov>
Subject: RE: Draft Notes for EPRI mtg 6/6

Carol,

I have a number of things to do today. I will see what I can do.
CMB can provide its input to Erick. I can add to it later, if needed.

CIB staff has already developed one-pagers for RG1.99 and xLPR.

The topics on Adv. Man. And Gen IV materials come from EPRI. EPRI will be providing brief to our management on those two topics.

I have a meeting with Steve Bajorek on IAP 2. I will ask him what Mike Case wants. As you know that topics on IAPs is led by Mike Case. We can certainly provide Brian some talking points on our efforts.

Raj

From: Moyer, Carol
Sent: Wednesday, May 17, 2017 6:17 PM
To: Iyengar, Raj <Raj.Iyengar@nrc.gov>
Cc: Frankl, Istvan <Istvan.Frankl@nrc.gov>; Martinez Rodriguez, Erick <Erick.MartinezRodriguez@nrc.gov>
Subject: Draft Notes for EPRI mtg 6/6
Importance: High

Raj,

I have been drafting some notes for the EPRI-NRC management meeting on 6/6, but I don't want to duplicate your efforts on this. Can we combine what we have collected so far, and then see what is missing?

There are topics here that clearly fall within CIB's scope, e.g., RPV embrittlement (RG 1.99), and some that belong to Ian's branch. Also, I let Steve Bajorek know that I would draft some notes on Advanced Reactors, but that I would be looking to him to fill in status on the computational codes.

Steve let me know that Brian would like to see draft notes by Thursday (tomorrow), so I hope that we can discuss this in the morning.

Thanks,
Carol

Carol E. Moyer
Sr. Materials Engineer
U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
MS: T-10A36
Washington, DC 20555-0001
carol.moyer@nrc.gov
301-415-2153

Subject:	Ex-Plant Harvesting Coordination Meeting
Location:	HQ-TWFN-10A73-8p
Start:	Wed 10/18/2017 9:00 AM
End:	Wed 10/18/2017 10:00 AM
Show Time As:	Tentative
Recurrence:	Weekly
Recurrence Pattern:	every 2 week(s) on Thursday from 2:30 PM to 3:30 PM
Meeting Status:	Not yet responded
Organizer:	Hiser, Matthew
Required Attendees:	Purtscher, Patrick; Audrain, Margaret; Tregoning, Robert
Resources:	HQ-TWFN-10A73-8p

I'll be off Thursday afternoon – any chance we can move this to Wednesday morning?

Setting up a standing every other week meeting on harvesting to help us stay on track and keep making progress.

Topics:

- Sources of Materials
- Prioritization of Data Needs
- PNNL TLR

Subject:	Ex-Plant Harvesting Coordination Meeting
Location:	10th floor huddle
Start:	Thu 10/19/2017 9:30 AM
End:	Thu 10/19/2017 10:30 AM
Show Time As:	Tentative
Recurrence:	Weekly
Recurrence Pattern:	every 2 week(s) on Thursday from 2:30 PM to 3:30 PM
Meeting Status:	Not yet responded
Organizer:	Hiser, Matthew
Required Attendees:	Purtscher, Patrick; Audrain, Margaret; Tregoning, Robert

I'll be off Thursday afternoon – any chance we can move this to Thursday morning?

Setting up a standing every other week meeting on harvesting to help us stay on track and keep making progress.

Topics:

- Sources of Materials
- Prioritization of Data Needs
- PNNL TLR

From: Hiser, Matthew
Sent: Thursday, October 19, 2017 9:31 AM
To: Tregoning, Robert
Subject: Ex-Plant Harvesting Coordination Meeting

Meg is in, so we'll meet – I can call you on the same number.

Matthew Hiser
Materials Engineer
US Nuclear Regulatory Commission | Office of Nuclear Regulatory Research
Division of Engineering | Corrosion and Metallurgy Branch
Phone: 301-415-2454 | *Office: TWFN 10D62*
Matthew.Hiser@nrc.gov

From: Hiser, Matthew
Sent: Thursday, October 19, 2017 10:13 AM
To: Audrain, Margaret
Subject: Ex-Plant Harvesting Coordination Meeting

Hi Meg,

The names Rob mentioned at ANL are Omesh Chopra and Bill Shack. I'm sure Bogdan will know who they are; my understanding is both authored numerous NUREGs over the years…

Thanks!
Matt

Matthew Hiser
Materials Engineer
US Nuclear Regulatory Commission | Office of Nuclear Regulatory Research
Division of Engineering | Corrosion and Metallurgy Branch
Phone: 301-415-2454 | *Office: TWFN 10D62*
Matthew.Hiser@nrc.gov

From: Hiser, Matthew
Sent: Friday, December 01, 2017 3:33 PM
To: Frankl, Istvan; Tregoning, Robert; Purtscher, Patrick; Audrain, Margaret
Subject: DE Briefing on Harvesting
Attachments: Harvesting One Pager 12-1-17.docx

Note to requester: Attachment to email document immediately follows.

Hi Steve,

I have attached a draft one-pager that could be used to brief Brian and Chris on the harvesting efforts in the context of their questions regarding the ANL travel. Do you mind if I go ahead and schedule something with them for next week?

Meg, Pat, and Rob, please feel free to edit / comment on this draft one-pager as necessary.

Thanks!
Matt

Ex-Plant Materials Harvesting One-Pager

Motivation and Objective:

- Ex-plant materials are valuable because they have been exposed to actual in-service plant operating conditions (temperature, irradiation, coolant, etc.)
    - Generally, research involves accelerated, simulated aging conditions in a lab which may not be as representative of actual in-service aging
    - Highly representative materials (actual plant components) and aging conditions reduces the uncertainty associated with the applicability of research findings.
- With plants shutting down both in the U.S. and Europe, there are increasing opportunities to harvest components from decommissioning plants.
- Insights from ex-plant harvesting would support regulatory decisions for subsequent license renewal (SLR), and could have implications for the current license period
    - There is a task in the new UNR for SLR from NRR/DLR requesting RES to investigate opportunities for harvesting where appropriate.

Past Activities:

- Workshop in March 2017
    - NRC staff hosted a 2-day workshop with interested stakeholders, including domestic and international utilities and research organizations, to discuss benefits and challenges associated with ex-plant harvesting.
    - Sessions covered motivation for harvesting, data needs, sources of materials, lessons learned, the practical aspects of harvesting, and harvesting decision-making and planning
    - The discussion focused on the importance of clearly identifying the need and purpose for performing a harvesting project. All participants agreed harvesting is a complex and expensive proposition, but one that can be worthwhile if the need is clearly defined and addressed.
- PNNL Report on Harvesting Criteria
    - PNNL has produced a draft final report for NRC on criteria for harvesting decision-making and planning
    - Provides overview of past harvesting efforts and lessons learned as well as suggestions for approach to prioritize data needs for harvesting
- PLiM
    - NRC staff provided a presentation, poster, and paper for the recent PLiM conference in October 2017.

Path Forward:

- Focused on two parallel efforts:
    - Developing alignment within NRC on prioritization of harvesting data needs
        - Use criteria identified in PNNL report establish effective prioritization scheme for relevant areas: RPV, RPV internals and other metals, electrical components, concrete
    - Developing a database identifying sources of materials for harvesting
        - Start with lab-based “boneyards” of prior harvested materials
            - Visits to ANL, PNNL, and ORNL (leveraged with already planned travel) support this activity
        - Coordinate with DOE NSUF Nuclear Fuel and Materials Library (NFML) run by INL as appropriate and beneficial

From: Oberson, Greg
Sent: Thursday, June 09, 2016 11:48 AM
To: Hiser, Matthew
Subject: contact Al Ahluwalia

Matt,
You could contact Al about the Korea plant material harvesting: kahluwal@epri.com

From: Frankl, Istvan
Sent: Monday, June 06, 2016 3:02 PM
To: Hull, Amy
Cc: Hiser, Matthew
Subject: COR Change for Strategic Harvesting Contract with PNNL

Importance: High

Follow Up Flag: Follow up
Flag Status: Flagged

Amy,

Are you OK with Pat assuming COR duties for subject contract?

You will continue to be retained as Technical Monitor.

Please let me know ASAP.

Thanks,

Steve

From: Tregoning, Robert
Sent: Wednesday, November 18, 2015 10:55 AM
To: Hiser, Matthew; Hull, Amy
Subject: DLR user need

Matt/Amy:

So NRR\DLR agreed to add the harvesting task to UNR 2010-006. Please verify with Steve that he wants you to start working on this with DLR staff (Bennett/Hiser)….

RT

Robert Tregoning
Technical Advisor for Materials
US Nuclear Regulatory Commission
Two White Flint North, M/S T-10 A36
11545 Rockville Pike
Rockville, MD 20852-2738
ph: 301-415-2324
Blackberry: [redacted] (b)(6)
fax: 301-415-6671

Subject:	Discuss PLiM Presentation on Harvesting
Location:	HQ-OWFN-08B02-12p
Start:	Thu 10/12/2017 2:00 PM
End:	Thu 10/12/2017 3:00 PM
Show Time As:	Tentative
Recurrence:	(none)
Meeting Status:	Not yet responded
Organizer:	Hiser, Matthew
Required Attendees:	Hiser, Allen; Tregoning, Robert; Moyer, Carol; Hull, Amy; Purtscher, Patrick
Resources:	HQ-OWFN-08B02-12p

From: Moyer, Carol
Sent: Thursday, July 27, 2017 10:31 AM
To: Hiser, Matthew
Subject: Decommissioning meeting next June

Hi Matt,

Just FYI, I came across an advertisement for this meeting on Decommissioning, to be held next June in TN:

http://www.exchangemonitor.com/evtx/decommisioning-2018/

This appears to be a business/commercial meeting, not a technical conference. But I thought it might be good to know about it, for scheduling & networking purposes, related to your harvesting work.

Carol

Carol Moyer
Sr. Materials Engineer
RES/DE/CMB
carol.moyer@nrc.gov
301-415-2153

From: Hiser, Matthew
Sent: Friday, May 15, 2015 8:21 AM
To: Focht, Eric; Murdock, Darrell; Sircar, Madhumita
Cc: Hull, Amy
Subject: Ex-Plant Materials Harvesting
Attachments: title and time: June materials meeting

Note to requester: Attachment to this email document is immediately following.

Hi Mita, Darrell, and Eric,

I am working with Amy Hull in my branch on an effort associated with strategic harvesting of ex-plant materials. This effort is just getting underway, but we would like to present the concept at an NRC-industry materials meeting in early June (see attached email). The purpose of this effort is to develop a more systematic proactive "strategic" approach to ex-plant material harvesting, rather than the more reactive opportunistic approach to date. It is important to share this concept with industry, since they will be vital in providing connections/communication to allow future harvesting projects to take place.

I am putting together a slide or two on the reactor internals materials harvesting project at Zorita that I am involved with. I understand each of you have been / are involved with other harvesting efforts at Zion and Zorita on cables, concrete, and neutron absorbers. If you could just provide a slide or two with a high-level overview of the harvesting project and at least briefly touch on how the harvesting opportunity came together, that would be great.

Thanks!
Matt

From: Hull, Amy
Sent: Friday, May 15, 2015 7:44 AM
To: Tregoning, Robert
Cc: Hiser, Matthew; Frankl, Istvan
Subject: title and time: June materials meeting

Strategic Approach for Obtaining Material and Component Aging Information

Amy Hull & Matt Hiser

30 minutes, Matt will talk 15 minutes about current approach to (and results from) ex-plant harvesting and then I will talk 15 about where we are going

---

From: Tregoning, Robert
Sent: Thursday, May 14, 2015 3:43 PM
To: Hull, Amy
Subject: June materials meeting

Amy:

I just need a title and an allotted time for your Ex-plant Material Database presentation for the June meeting. Can you send me something either today or early tomorrow?

Thanks so much,

Rob

Robert Tregoning
Technical Advisor for Materials
US Nuclear Regulatory Commission
21 Church Street, M/S CS-5A24
Rockville, MD 20850
ph: 301-251-7662
Blackberry: [redacted] (b)(6)
fax: 301-251-7425

From: Hull, Amy
Sent: Tuesday, November 10, 2015 3:11 PM
To: Hiser, Matthew
Subject: Bloom approved time of Heather, Bernie, Bennett

person	NRC affiliation	Why?
Frankl. Steve	CMB	Chair (amy asked his interest earlier)
Hiser, Matt	CMB	Member (alternate COR, technical monitor); Zorita ex-plant harvesting
Hull, Amy	CMB	Member (COR, TM)
Tregoning, Rob	RES/DE	Sr advisor for work
Kanney, Joe	RES/DRA	Member (technical monitor); LTRP
Steve Bloom approved availability of Bernie, Heather, Bennett	NRR/DLR/RSRG	Bernie – knows plants Heather – knows regional folks Bennett – plant audits, OpE
Murdock, Daryl	RES/DE	electrical
Burke, John	RES/DE	concrete
Mike Benson	RES/DE/CIB	CODAP POC; database development
Oberson, Greg	RES/DE/CMB	Zion questionnaire; EMDA; ex-plant harvesting
Cumblidge, Steve; Dave Alley	NRR/DE	Member (PNNL & PMMD background)
Bob Hardies	NRR/DE	Member
Gary Stevens	NRR/DE	Member
Darrell Dunn or John Wise (Csontos branch)	NMSS/DSFM/RMB	Member (decommissioned plant availability)
Watson, Bruce	NMSS	Recommended by Steve Bloom

Amy B. Hull, Ph.D
Senior Materials Engineer
RES/DE/CMB (office T10-D49)
US Nuclear Regulatory Commission
11545 Rockville Pike
Rockville, Maryland 20852
Telephone: (301) 415-2435
e-mail: amy.hull@nrc.gov

From: Hull, Amy
Sent: Monday, March 05, 2018 8:47 AM
To: Hiser, Allen; Moyer, Carol; Hiser, Matthew
Cc: Frankl, Istvan; Rudland, David; Ruffin, Steve; Frankl, Istvan
Subject: attached: RIC Harvesting & AM Posters
Attachments: RIC Poster 6 on AM_20180213.pptx; RIC Poster 8 on Harvesting_20180213.pptx

Note to requester: Attachments to this email document are immediately following.

See attached. I also included the AM poster.

From: Hiser, Allen
Sent: Thursday, March 01, 2018 3:58 PM
To: Hull, Amy <Amy.Hull@nrc.gov>; Moyer, Carol <Carol.Moyer@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>
Cc: Frankl, Istvan <Istvan.Frankl@nrc.gov>; Rudland, David <David.Rudland@nrc.gov>; Ruffin, Steve <Steve.Ruffin@nrc.gov>
Subject: RIC Harvesting Poster
Importance: High

Can I get a copy of the RIC harvesting poster?

Thanks,
Allen

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Protecting People and the Environment

RIC 2018

Review of Additive Manufacturing by Direct Metal Laser Melting

A. Hull, T. Herrity, and C. Moyer, U.S. Nuclear Regulatory Commission (NRC)

Background and Motivation

The NRC has been informed that parts created by additive manufacturing (AM) are being considered for applications in the operating fleet as early as calendar year 2018. In 2017, industry prototyping efforts involved use of the direct metal laser melting (DMLM) method to manufacture parts for reactor components. The Office of Nuclear Regulatory Research is beginning to evaluate the technology to gain insight into any technical issues that must be addressed to assure safety and reliability of specific DMLM-produced components that may be accepted by the NRC, including design, precursor materials, finished material properties, structural integrity, nondestructive evaluation, and quality assurance. This welding-based process may be susceptible to, for example, porosity, systematic defects, and anisotropy of properties not currently addressed for conventionally manufactured components.

On November 28–29, 2017, the NRC held a public meeting entitled, "Additive Manufacturing for Reactor Materials and Components." Presentations from 28 speakers representing American and international industry, EPRI, NEI, DoD facilities, DOE and National Laboratories, ASME, ASTM, ANSI, FAA, NASA, and NIST are available in ADAMS (Accession No. ML17338A880).

Current Activities

The NRC is developing a strategic plan to address the use of additive manufacturing for reactor materials and components. The NRC plans to leverage ongoing research and evaluation of this technology being performed by Federal counterparts.

The NRC strategic plan will focus on topic areas of interest identified at the Additive Manufacturing for Reactor Materials and Components public meeting:

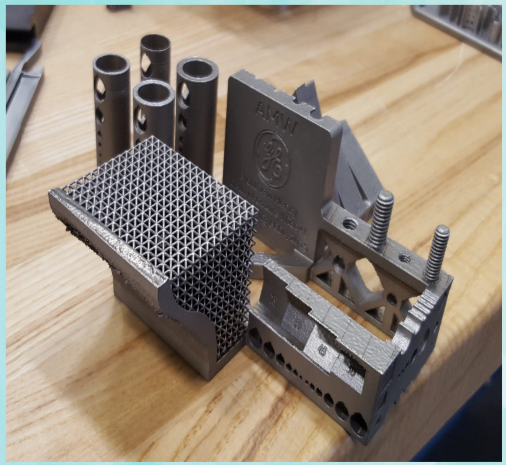
- Quality of AM materials and components for nuclear power plants
- Codes and standards development for AM
- Properties and structural performance
- Service performance/aging degradation
- Regulatory infrastructure

Path Forward

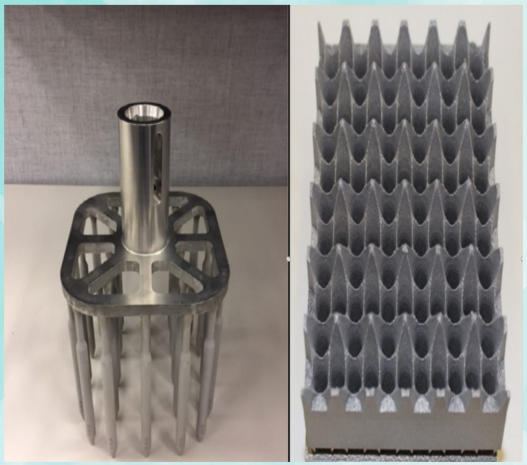
AM has been identified as a technique that the nuclear industry may use in the future. Prevailing questions are: How will AM be used in nuclear power plants, and when? What is the regulatory infrastructure for determining how safe it is?

NRC areas of interest include the quality, properties, and structural performance of AM parts, including their inspectability. The service performance and aging degradation of AM parts are critical. It will be essential to compare the performance of parts from AM and those from conventional manufacturing processes.

Challenges to be addressed include the limited understanding of acceptable ranges of variation for key manufacturing parameters, limited understanding of key failure mechanisms and material anomalies, the potential for systematic defects, cybersecurity considerations, lack of industry databases, and lack of industry specifications and standards. The development of codes and standards for AM is key to successful implementation.



DMLM Process Demonstration Specimen at GE Power Advanced Manufacturing Works, Greenville, SC, C. Moyer, December 11, 2017.



Westinghouse's DMLM Examples: Thimble Plugging Device, Advanced Debris Filtering Bottom Nozzle, B. Cleary, November 28, 2017.

Standards Development Organizations Involved with AM Standardization, J. McCabe, November 29, 2017

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Protecting People and the Environment

RIC 2018

Harvesting of Aged Materials from Nuclear Power Plants

M. Hiser[a], P. Purtscher[a], P. Ramuhalli[b], A.B. Hull[a], and R. Tregoning[a]; [a]U.S. Nuclear Regulatory Commission (NRC), [b]Pacific Northwest National Laboratory

Background and Motivation

Recent developments in the nuclear industry include stronger interest in extended plant operation and plans to shut down a number of nuclear power plants (NPPs). In the United States, there is strong interest in extending NPP lifespans through subsequent license renewal (SLR) from 60 to 80 years.

Extended plant operation and SLR raise a number of technical issues that may require further research to understand and quantify aging mechanisms. U.S. utilities and the U.S. Nuclear Regulatory Commission (NRC) have focused on the aging of systems, structures, and components and in particular four key SLR issues: reactor pressure vessel embrittlement, irradiation-assisted stress-corrosion cracking of reactor internals, concrete structures and containment degradation, and electrical cable qualification and condition assessment.

Meanwhile, in recent years, a number of NPPs, both in the United States and internationally, have shut down or announced plans to shut down for various reasons, including economic, political, and technical challenges. Unlike in the past when there were very few plants shutting down, these new developments provide opportunities for harvesting components that were aged in representative light-water reactor environments.

In a third related development, economic challenges and limited budgets have restricted the resources available to support new research, including harvesting programs. Given this constrained budget environment, aligning interests and leveraging with other organizations is important to allow maximum benefit and value for future research programs.

Current Activities

The NRC has recently undertaken an effort, with the assistance of Pacific Northwest National Laboratory, to develop a strategic approach to harvesting aged materials from NPPs. Because of limited opportunities, past harvesting efforts have been reactive to individual plants shutting down and beginning decommissioning. Given the expected availability of materials from numerous plants and anticipated research needs to better understand aging out to 80 years of operation, the NRC is pursuing a more proactive approach to prioritize the data needs best addressed by harvesting and identify the best sources of materials to address high-priority data needs for regulatory research.

The first step in this strategic approach is to prioritize data needs for harvesting. A data need describes a particular degradation scenario and should be defined with as much detail as appropriate in terms of the material (alloy, composition, etc.) and environment (temperature, fluence, chemistry, etc.).

Potential Criteria for Harvesting Prioritization

A number of criteria may be considered when prioritizing the data needs for harvesting, including the following:

- Applicability of harvested material for addressing critical gaps
  - Harvesting for critical gaps is prioritized over less essential technical gaps.
- Ease of laboratory replication of the degradation scenario
  - For example, simultaneous thermal and irradiation conditions are difficult to replicate, and accelerated aging may not be feasible for a mechanism sensitive to dose rate.
- Unique field aspects of degradation
  - For example, unusual operating experience or legacy material (fabrication methods, etc.) is no longer available.
- Fleet-wide vs. plant-specific applicability of data
  - There is greater value in addressing an issue applicable to a larger number of plants.
- Harvesting cost and complexity
  - For example, harvesting unirradiated concrete or electrical cables is less expensive and less complex than harvesting from the reactor internals or reactor pressure vessel.
- Availability of reliable inservice inspection (ISI) techniques for the material/component
  - If mature inspection methods exist and are easy to apply, harvesting may be less valuable.
- Availability of materials for harvesting
- Timeliness of the expected research results relative to the objective.

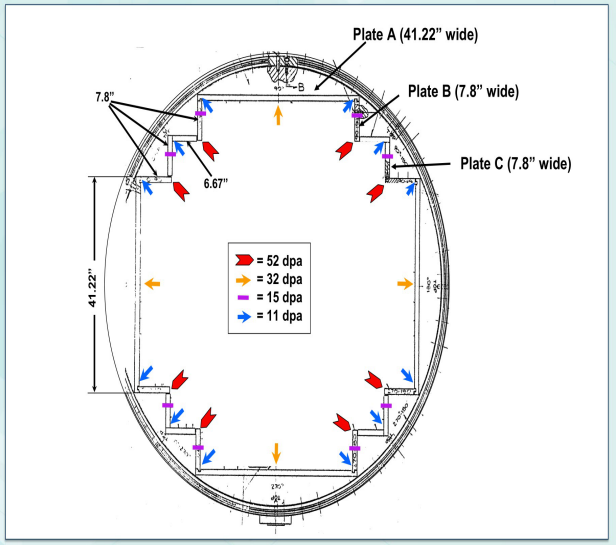
Lifting operation for irradiated materials transport cask

Harvesting Database

The NRC is pursuing the development of a database for sources of materials for harvesting, which could include both previously harvested materials and those available for future harvesting. This database would allow for aligning high-priority data needs to the available sources of materials. The level of detail for the database should be appropriate for the factors influencing decisionmaking. The NRC is interested in engaging with other organizations in developing the database.

Path Forward

In the NRC's experience, harvesting can yield highly representative and valuable data on materials aging, but these efforts will be challenging. Having a clearly defined objective and early engagement with other stakeholders are keys to success. As specific harvesting opportunities are identified through this strategic approach, the NRC welcomes opportunities for cooperation and leveraging of resources with other interested research organizations.



Example of reactor internals harvesting plan

From: Hull, Amy
Sent: Friday, May 19, 2017 10:42 AM
To: Hiser, Matthew
Subject: Appendix 2 has what I wanted ---- sorry,...finishing now, 3rd version lost on citrix...[eom]: pls will you send me the draft summary report?: 3 sections revised -- CMB update 20170517.

From: Hull, Amy
Sent: Friday, May 19, 2017 10:37 AM
To: Hiser, Matthew <Matthew.Hiser@nrc.gov>
Subject: commenfinishing now, 3rd version lost on citrix....: I will take along printout to (b)(6) and get any comments back to you by 8am tomorrow morning.....[eom]: pls will you send me the draft summary report?: 3 sections revised -- CMB update 20170517.docx

...a main thing, I think it would be useful to attach the agenda to the summary report as an appendix, and to have a table of contents at the front (since it is already 26 pages). This will be archived in ADAMS and you want to have the information easily retrievable in the future.

I will send you the detailed corrections but as it stands it does not include title of presentations and attaching the agenda would avoid having to write this in.

From: Hull, Amy
Sent: Thursday, May 18, 2017 8:31 AM
To: Hiser, Matthew <Matthew.Hiser@nrc.gov>
Subject: I will take along printout to (b)(6) and get any comments back to you by 8am tomorrow morning.....[eom]: pls will you send me the draft summary report?: 3 sections revised -- CMB update 20170517.docx

From: Hiser, Matthew
Sent: Tuesday, May 16, 2017 10:42 AM
To: Hull, Amy <Amy.Hull@nrc.gov>
Subject: RE: pls will you send me the draft summary report?: 3 sections revised -- CMB update 20170517.docx

Hi Amy,

Sure thing – here you go ☺ Please take a look and provide any comments or edits.

Thanks!
Matt

Matthew Hiser
Materials Engineer
US Nuclear Regulatory Commission | Office of Nuclear Regulatory Research
Division of Engineering | Corrosion and Metallurgy Branch
Phone: 301-415-2454 | *Office: TWFN 10D62*

Matthew.Hiser@nrc.gov

From: Hull, Amy
Sent: Tuesday, May 16, 2017 10:34 AM
To: Hiser, Matthew <Matthew.Hiser@nrc.gov>
Subject: pls will you send me the draft summary report?: 3 sections revised -- CMB update 20170517.docx

Strategic Approach for Obtaining Material and Component Aging Information (Amy Hull, Pat Purtscher, Matt Hiser) (LTRP)

- Strategic harvesting is one of the new tasks in the new SLR UNR that will replace NRR-2010-006. Staff are working on specific task for Strategic Harvesting in NRR-2017-006.
- Final deliverable expected by early 2017. Final report publication will wait until after harvesting workshop in March.
- Proceedings from the Ex-Plant Materials Harvesting Workshop, held on March 7-8, are compiled in a CMB SharePoint site http://fusion.nrc.gov/res/team/de/cmb/LTO/default.aspx?RootFolder=%2Fres%2Fteam%2Fde%2Fcmb%2FLTO%2FProgram%20Documents%2FStrategic%20Approach%20for%20Obtaining%20Material%20and%20Component%20Aging%20Information&FolderCTID=0x012000A4119D2C08121A4CAE71D67AEB499BF9&View={A08F45B4-F7E9-4960-9890-37F16055A16F} . Good frank discussion with external parties from DOE, EPRI, and international stakeholders on benefits and challenges of harvesting.
- CMB staff preparing workshop summary report (expected by end of May) and follow-up on action items with interested workshop attendees focused on a database for sources of materials and prioritizing data needs for harvesting.
- Pradeep Ramuhalli, PNNL contractor, visited RES/DE/CMB staff concerning this project on 4/18/2017. This was a side-trip for another NDE/OLM project funded by DOE related to advanced reactors.
- One-pager submitted for DE management review.

From: Hull, Amy
Sent: Tuesday, May 16, 2017 10:28 AM
To: Frankl, Istvan (Istvan.Frankl@nrc.gov) <Istvan.Frankl@nrc.gov>; Moyer, Carol <Carol.Moyer@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>
Subject: 3 sections revised -- CMB update 20170517.docx

From: Hull, Amy
Sent: Monday, April 20, 2015 12:01 PM
To: Frankl, Istvan
Subject: answer plus more....: ACTION: Topics for NRC/Industry Materials Meeting in June

Categories: Strategic R&D ex-plant materials

(1) At the 3/13/2014 NRC/NEI quarterly meeting, both EPRI and PWROG mentioned that they were completing the review of their documents from the perspective of SLR. At that meeting, I mentioned the upcoming June meeting and how that would be a most welcome presentation (listing of references that both groups will revise for SLR, we need to make sure that our references in SLRGDs are consistent with that).

(2) Here are my notes from our discussion last Thursday. Please read below and let me know if I do not adequately capture your thoughts. I can give the presentation anytime after May 12 (after NEI and NESCC presentations). Please can you direct me to where I can get access to the PWSCC briefing slides? I guess they are on Gdrive somewhere.

4/16/2015 Steve Frankl initiated discussion about Mgt briefing on SLR

- Somewhat parallel to PWSCC briefing just completed (amy action – get slides!)
- 40 slides, maybe 45 minutes with 15 minutes for discussion
- Briefing on entire scope of RES activity with license renewal & aging management
  - Historic
  - Where now
  - RES deliverables for DLR
- Talk about Commission requests
  - Be more prepared
- During recent mgt retreat, SLR was singled out on gap analysis and action plans
  - Relationship between regulatory & technical (research) issues
  - Look at gaps in process
  - Possible UNR revision or addition
- Build program
  - Discuss action plans about how going forward
  - Resource needs (additional staff for CMB)
  - Relationship of CMB with other parts of RES (DRA and DE (Rudland, Burke, Sydnor, etc))
  - New SOW on harvesting ex-plant materials & database of research prioritization
  - How to get more out of our MOUs with DOE LWRS and EPRI LTO
  - International participation in programs (IAEA, CSNI, IFRAM, etc)

From: Frankl, Istvan
Sent: Thursday, April 16, 2015 5:19 PM
To: RES_DE_CMB
Subject: ACTION: Topics for NRC/Industry Materials Meeting in June

All,

Please review Rob's request below and identify topics that we want to make sure are covered during subject materials meeting. Please provide inputs to me no later than COB Wednesday.

Thanks,

Steve

-----Original Appointment-----
From: Tregoning, Robert
Sent: Wednesday, April 01, 2015 10:38 AM
To: Tregoning, Robert; Rudland, David; Frankl, Istvan; Rosenberg, Stacey; Alley, David; Karwoski, Kenneth; Mitchell, Matthew
Subject: Topics for NRC/Industry Materials Meeting in June
When: Thursday, April 23, 2015 9:00 AM-10:00 AM (UTC-05:00) Eastern Time (US & Canada).
Where: HQ-OWFN-09B02-12p

All:

Purpose is to identify topics that we want to make sure are covered during the materials meeting. Please come to the meeting with your recommendations after polling your staff. The draft topic list will then be shared with industry to finalize the meeting agenda. Meeting is a little later than normal this year, but this is the earliest date/time that everyone is available.

Cheers,

Rob

From: Hiser, Matthew
Sent: Wednesday, November 08, 2017 4:33 PM
To: Purtscher, Patrick; Audrain, Margaret; Tregoning, Robert
Subject: Ex-Plant Harvesting Coordination Meeting
Attachments: Harvesting Needs Prioritization 11-8-17.xlsx

Note to Requester: Attachment to this email document is immediately following.

Updated criteria titles and "other metals" spreadsheet per the feedback received last week.

Let's try to run these "other metals" ideas and discuss at our next meeting.

Thanks!
Matt

Criteria Title	Description	**Scoring Guidance** **H = High** **MH = Medium-high** **M = Medium** **ML = Medium-low** **L = Low**
Criticalness of Technical Gap Addressed	Harvesting to address critical gaps should be prioritized over less essential technical gaps	
Difficulty of Laboratory Replication	Degradation mechanisms that are harder to replicate with simulated aging conditions would be of higher priority for harvesting. For example, simultaneous thermal and irradiation conditions are difficult to replicate outside of the plant environment. Alternatively, accelerated aging may not be feasible for a mechanism sensitive to dose rate. These two degradation mechanisms may be best evaluated using harvested materials.	
Uniqueness Field Aspects of Degradation	For example, legacy materials (e.g., fabrication methods, composition) that are no longer available, but may play an important role in a potential degradation mechanism, would have a higher priority than harvesting materials that can be obtained from other sources.	
Applicability to US Operating Fleet	There is greater value in developing knowledge to address an issue that may be applicable to a larger number of plants compared to one that may only affect a relatively small number of plants.	
Absence of Available Inspection Methods	If mature inspection methods exist and are easy to apply to monitor degradation, harvesting may be less valuable. If inspection methods do not exist, harvesting may be essential to ensure confidence in the assessment of age-related degradation in that particular component.	
Lower Confidence in Relevant AMP	The less confidence that NRC staff has in the effectiveness of the relevant AMP, the higher priority for harvesting.	
Harvesting cost and complexity	Activities with higher costs and complexity are less attractive than similar activities with lower costs and that are simpler to execute.. For example, harvesting unirradiated concrete or electrical cables is less expensive and less complex than harvesting from the RPV internals or the RPV.	
Timeliness of results	The ability of a potential harvesting program to provide timely results to support either a technical or regulatory need is important. Having high confidence that results will be timely increases the priority.	
Availability of materials for harvesting	The availability of materials to harvest for a particular data need is clearly essential and increases the priority.	

	Basic Info		Technical Criteria														Cost / Complexity		Project Specific	
Need Description	**Purpose / Testing Planned**	**Technical Knowledge Gained**	**Criticalness of Technical Gap Addressed**		**Difficulty of Laboratory Replication**		**Uniqueness Field Aspects of Degradation**		**Applicability to US Operating Fleet**		**Absence of Available Inspection Methods**		**Lower Confidence in Relevant AMP**		**Score Average**	**Basis for Priority**	**Cost**	**Complexity**	**Timeliness of results**	**Availability of materials for harvesting**
METALS			**Score**	**Comment**	**Score**	**Comment**	**Score**	**Comment**	**Score**	**Comment**	**Score**	**Comment**	**Score**	**Comment**						
High fluence reactor internals	Void swelling, mechanical properties, IASCC	Likely extent of void swelling in PWRs during extended operation and impact on cracking		Fills data gap for extended plant operation		No		Vintage compositions and realistic irradiation conditions		Applicable to high-fluence components in most PWRs		None for void swelling; MRP-227 primarily visual testing		Some confidence in MRP-227 to identify issues in sufficient time		Very high cost, but lack of data is significant challenge to regulatory decisions	Very High		TBD	TBD
Thermally aged unirradiated CASS	Fracture toughness and microstructure	Fracture toughness data in real conditions to compare to accelerated aging data		Validate accelerated aging data		No		Vintage compositions and realistic irradiation conditions		Applicable to PWRs more than BWRs (higher temps)		No ISI to measure loss of FT				Moderate cost, but would greatly increase confidence in large set of accelerated aging data	Medium			
Moderate fluence (1-2 dpa) CASS	Fracture toughness and microstructure	Fracture toughness data near limit requiring further evaluation		Fills data gap for regulatory decision-making		No		Vintage compositions and realistic irradiation conditions		Applicable to PWRs more than BWRs (higher temps and fluence)		No ISI to measure loss of FT				High cost, but would increase confidence in regulatory position	High			
Metallic components with known flaws	NDE and destructive examination	Determine whether SCC mitigation methods are effective at preventing SCC; effectiveness of NDE at detection and sizing		Validate NDE and mitigation method effectiveness		Not to provide real-world validation		Actual effectiveness of NDE and mitigation methods in plant environment essential		Applicable to all plants						Moderate cost, but would greatly increase confidence in NDE and mitigation methods	Medium			
Metallic components with limiting fatigue life	NDE and destructive examination	Determine whether fatigue flaws are present in high usage locations		Validate fatigue life methodologies		Not to provide real-world validation		Vintage compositions and realistic loading conditions		Applicable to all plants						Moderate cost, but would greatly increase confidence in fatigue life calculations	Medium			

Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Benefit / Significance	Cost	Alternative to Harvesting?	Priority / Value	Basis for Priority	Unique aspects of harvested materials	ISI availablility?
METALS									
RPV - High fluence & high shift vessel with well-established unirradiated properties	Measure fluence, toughness, & chemistry as a function of through-thickness position	Through thickness section to validate fluence & attenuation models	Increases confidence in existing regulatory approach	High	No	**LOW**	High cost not justified by benefit given surveillance specimens and well-established emrittlement trend correlations	Vintage compositions and irradiation conditions	
RPV - Samples from virtually any vessel	Enable measurement of both the Charpy transition curve and master curve transition temperature T0	Provides data supporting evolution from the use of correlative (Charpy-based) to direct measurement (fracture toughness-based) approaches	Increases confidence in existing regulatory approach	High	No	**LOW**	High cost not justified by benefit given surveillance specimens and well-established emrittlement trend correlations	Vintage compositions and realistic irradiation conditions	

Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Benefit / Significance	Cost	Alternative to Harvesting?	Priority / Value	Basis for Priority	Unique aspects of harvested materials	ISI availablilitv?
ELECTRICAL									
Low and medium voltage cables				Medium		**HIGH**			
Cables protected with fire retardant coating				Medium					
1E MOVs from harsh and mild environments				Medium					
1E Air operated valves; 4160									
1E breakers				Low					
1E Molded case breakers 480V, 250V DC, 125 VDC,				Low					
1E Relays from mild environment GE – HFA, Agastat timing relays, any from Westinghouse, Potter Brumfield, Stuthers Dunn etc.,				Low					
Batteries				Low					
Electrical penetrations									
Fire research interest									
Electrical enclosures									
Distribution: switchgear, MCCs, LCs | Control: Horseshoe, SSCP, ASP, etc.									

Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Benefit / Significance	Cost	Alternative to Harvesting?	Priority / Value	Basis for Priority	Unique aspects of harvested materials	ISI availablility?
METALS									
CONCRETE									
Structures exposed to high radiation	Change in properties due to irradiation effects	Loss of strength due to irradiation	Fills data gap for extended plant operation	High		**HIGH**			
Post-tensioned structures				Medium		**LOW**			
Corrosion of reinforcing steel, tendon, liner, embedment				Medium		**LOW**			
Spent fuel pool and transfer canal-boric acid attack on concrete in PWRs				Medium		**LOW**			
Alkali Aggregate Reaction				Medium		**LOW**			
Large structural sections for testing	Effects of concrete aging on structural capacity		Validate assumptions of aging effects at larger scales	High		**LOW**			

From: Tregoning, Robert
Sent: Tuesday, September 04, 2018 9:59 AM
To: Hiser, Matthew
Subject: Copy of Harvesting Needs Prioritization 8-31-18 rlt.xlsx
Attachments: Copy of Harvesting Needs Prioritization 8-31-18 rlt.xlsx

Note to requester: Attachment to this email is immediately following.

Matt:

Here's my stab at RPV. There are certainly several other rows that could be added to list, but I'll let Mark take first stab at that.

Cheers,

Rob

Criteria Title	Description	Scoring Guidance	
Criticalness of Technical Gap Addressed	Harvesting to address critical gaps should be prioritized over less essential technical gaps	**H = high risk significance / little to no available data** **MH = Medium-high risk significance / limited data available** **M = Moderate risk significance / some data available** **ML = low to moderate risk signficance / sufficient data available for regulatory decisions** **L = Low risk significance / large amount of data available**	**H = High** **MH = Medium-high** **M = Medium** **ML = Medium-low** **L = Low**
Importance of Harvested Materials over Laboratory Aging	Key considerations are the ease of laboratory replication of aging mechanism and unique field aspects of the aging mechanism. Degradation mechanisms that are harder to replicate with simulated aging conditions would be of higher priority for harvesting. For example, simultaneous thermal and irradiation conditions are difficult to replicate outside of the plant environment. Alternatively, accelerated aging may not be feasible for a mechanism sensitive to dose rate. These two degradation mechanisms may be best evaluated using harvested materials. For unique field aspects, legacy materials (e.g., fabrication methods, composition) that are no longer available, but may play an important role in a potential degradation mechanism, would have a higher priority than harvesting materials that can be obtained from other sources with representative properties.	**H = Nearly impossible to replicate service enviroment / critically important to use harvested materials** **MH = Challenging to replicate service enviroment / important to use harvested materials** **M = Possible with some limitations to replicate service enviroment / moderately important to use harvested materials** **ML = Not challenging to replicate service enviroment / less important to use harvested materials** **L = Very easy to replicate service enviroment / not important to use harvested materials**	
Applicability to US Operating Fleet	There is greater value in developing knowledge to address an issue that may be applicable to a larger number of plants compared to one that may only affect a relatively small number of plants.	**H = All plants** **MH = All PWRs** **M = All BWRs or most PWRs** **ML = ~10-15 plants** **L = <5 plants**	
Regulatory Considerations Related to Inspections and AMPs	If mature inspection methods exist and are easy to apply to monitor degradation, harvesting may be less valuable. If inspection methods do not exist, harvesting may be essential to ensure confidence in the assessment of age-related degradation in that particular component.The less confidence that NRC staff has in the effectiveness of the relevant AMP, the higher priority for harvesting.	**H = No or very limited inspection methods available / low confidence in AMPs** **MH = Limited inspection methods available / low-to-moderate confidence in AMPs** **M = Some inspection methods available / moderate confidence in AMPs** **ML = Good inspection methods available / medium-high confidence in AMPs** **L = Effective, well-accepted inspection**	
Harvesting cost and complexity	Activities with higher costs and complexity are less attractive than similar activities with lower costs and that are simpler to execute.. For example, harvesting unirradiated concrete or electrical cables is less expensive and less complex than harvesting from the RPV internals or the RPV.	**H = Highly irradiated (>5 dpa)** **MH = Lightly irradiated / contaminated** **M = Minimal contamination or high effort unirradiated** **ML = Unirradiated, moderate effort expected** **L = Unirradiated, low effort expected**	
Timeliness of results	The ability of a potential harvesting program to provide timely results to support either a technical or regulatory need is important. Having high confidence that results will be timely increases the priority.		
Availability of materials for harvesting	The availability of materials to harvest for a particular data need is clearly essential and increases the priority.		

	Basic Info		Technical Criteria										Cost / Complexity		Project Specific	
Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Criticalness of Technical Gap Addressed		Importance of Harvested Materials over Laboratory Aging		Applicability to US Operating Fleet		Regulatory Considerations Related to Inspections and AMPs		Score Average	Basis for Technical Priority			Timeliness of results	Availability of materials for harvesting
RPV			Score	Comment	Score	Comment	Score	Comment	Score	Comment			Score	Comment		
RPV - High fluence & high shift vessel with well-established unirradiated properties	Measure fluence, toughness, & chemistry as a function of through-thickness position	Through thickness section to validate fluence & attenuation models	M	This work has been done before but the additional work should focus on higer fluences to verify that the attenuation trends expected are maintained.	MH	There are not many studies that irradiate 6 to 9 inches of steel so, from that standpoint, getting specimens from an RPV are important for studying attenuation	M	While the information should be generically appricable, if, for some reason, the results are only applicable to "high fluence" materials/locations, this might result in less relevance to lower fluence plants (including BWRs).	ML	The attenuation models have the least amount of supporting information compared to other aspects related to RPV embrittlement. However, studies to date have validated the conservativism of existing atttenuation models used in regulatory applications.	**M**	The attenuation study is slightly more important to me, just because there are fewer such studies that have been done. Being able to confirm expected trends at higher fluence levels would therefore be useful.	MH	Material is irradiated which will affect all aspects of specimen preparation and testing. Further, taking specimens at several through-thickness locations will increase cost.	The results would be timely if they are developed before 2024 or so to coincide with the additional information being collected from industry surviellance programs.	Other than Zion materials, I'm not aware of other RPVs that are available for harvesting.
RPV - Samples from virtually any vessel	Enable measurement of both the Charpy transition curve and master curve transition temperature T0	Provides data supporting evolution from the use of correlative (Charpy-based) to direct measurement (fracture toughness-based) approaches	M	I believe that enough data has been developed from both test and surveillance	ML	The only real advantage in my mind for having vessel material for this study is that there are no questions about the	MH	Any information developed should be generically applicable	ML	We have as good a confidence in RPV embrittlement than virtually any other degradation that we study. The only real	**M - ML**	While it's always useful to have more data, especially on RPV materials, I feel that our models already have a good technical basis.	MH	Material is irradiated which will affect all aspects of specimen preparation and testing.	The results would be timely if they are developed before 2024 or	Other than Zion materials, I'm not aware of other RPVs that are available for

	Basic Info		Technical Criteria										Cost / Complexity		Project Specific	
Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Criticalness of Technical Gap Addressed		Importance of Harvested Materials over Laboratory Aging		Applicability to US Operating Fleet		Regulatory Considerations Related to Inspections and AMPs		Score Average	Basis for Technical Priority			Timeliness of results	Availability of materials for harvesting
METALS			Score	Comment	Score	Comment	Score	Comment	Score	Comment			Score	Comment		
High fluence reactor internals	Void swelling, mechanical properties, IASCC	Likely extent of void swelling in PWRs during extended operation and impact on cracking	M	Fills data gap for extended plant operation	MH	Laboratory replication very difficult to impossible to achieve fluences with representative irradiation conditions	MH	Applicable to high-fluence components in most PWRs	MH	EPRI performing R&D on NDE for void swelling; MRP-227 uses primarily visual testing, which could detect void swelling once fairly significant	**3.75**	Significance of void swelling at higher fluences is uncertain, and inspections may detect onset of significant degradation	VH	Very high cost for highly irradiated internals		TBD
Thermally aged unirradiated CASS	Fracture toughness and microstructure	Fracture toughness data in real conditions to compare to accelerated aging data	MH	Validate accelerated aging data	H	Purpose of work would be to provide real-world validation of accelerated aging in lab testing	M	Most applicable to a subset of PWRs	H	No ISI method available to measure loss of FT	**4.25**	Would greatly increase confidence in large set of accelerated aging data with testing of unirradiated materials	M	Moderate cost for contaminated, but not irradiated, primary stsem components		
Moderate fluence (1-2 dpa) CASS	Fracture toughness and microstructure	Fracture toughness data near limit requiring further evaluation	ML	Confirm regulatory position	MH	May be possible, but difficult to replicate long-term aging and irradiation effects	M	Most applicable to a subset of PWRs	H	No ISI method available to measure loss of FT	**3.5**	Would increase confidence in regulatory position	H	High cost for irradiated components		
Metallic components with known flaws	NDE and destructive examination	Determine whether SCC mitigation methods are effective at preventing SCC; effectiveness of NDE at detection and sizing	MH	Validate NDE and mitigation method effectiveness	MH	Purpose of work would be to provide real-world validation of lab testing	H	Applicable to all plants	ML	Purpose of this work is to assess inspection and mitigation method effectiveness	**3.75**	Increase confidence in NDE and mitigation methods	M	Moderate cost for contaminated, but not irradiated, primary stsem components		
Metallic components with limiting fatigue life	NDE and destructive examination	Determine whether fatigue flaws are present in high usage locations	MH	Validate fatigue life methodologies	ML	Purpose of work would be to provide real-world validation of lab testing	H	Applicable to all plants	ML	Fatigue calculations inform sampling inspections of limiting fatigue locations	**3.25**	Increase confidence in fatigue life calculations	M	Moderate cost for contaminated, but not irradiated, primary stsem components		

	Basic Info		Technical Criteria										Cost / Complexity		Project Specific	
Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Criticalness of Technical Gap Addressed		Importance of Harvested Materials over Laboratory Aging		Applicability to US Operating Fleet		Regulatory Considerations Related to Inspections and AMPs		Score Average	Basis for Priority			Timeliness of results	Availability of materials for harvesting
ELECTRICAL			Score	Comment	Score	Comment	Score	Comment	Score	Comment			Score	Comment		
Low and medium voltage cables																
Cables protected with fire retardant coating																
1E MOVs from harsh and mild environments																
1E Air operated valves; 4160 1E breakers																
1E Molded case breakers 480V, 250V DC, 125 VDC,																
1E Relays from mild environment GE – HFA, Agastat timing relays, any from Westinghouse, Potter Brumfield, Stuthers Dunn etc.,																
Batteries																
Electrical penetrations																
Fire research interest																
Electrical enclosures																
Distribution: switchgear, MCCs, LCs | Control: Horseshoe, SSCP, ASP, etc.																

	Basic Info		Technical Criteria										Cost / Complexity		Project Specific	
Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Criticalness of Technical Gap Addressed		Importance of Harvested Materials over Laboratory Aging		Applicability to US Operating Fleet		Regulatory Considerations Related to Inspections and AMPs		Score Average	Basis for Priority			Timeliness of results	Availability of materials for harvesting
CONCRETE			Score	Comment	Score	Comment	Score	Comment	Score	Comment			Score	Comment		
Structures exposed to high radiation																
Post-tensioned structures																
Corrosion of reinforcing steel, tendon, liner, embedment																
Spent fuel pool and transfer canal-boric acid attack on concrete in PWRs																
Alkali Aggregate Reaction																
Large structural sections for testing																

From: Hiser, Matthew
Sent: Friday, December 01, 2017 2:51 PM
To: Tregoning, Robert; Audrain, Margaret; Purtscher, Patrick
Subject: Data Needs Prioritization
Attachments: Harvesting Needs Prioritization 12-1-17.xlsx

Note to requester: Attachment to this email is immediately following.

Here's the new version with updated criteria and scoring guidance per our discussion on Monday.

Let's try to work the examples with this version before the next meeting on Wednesday.

Thanks!
Matt

Criteria Title	Description	Scoring Guidance	
Criticalness of Technical Gap Addressed	Harvesting to address critical gaps should be prioritized over less essential technical gaps	**H = high risk significance / little to no available data** **MH = Medium-high risk significance / limited data available** **M = Moderate risk significance / some data available** **ML = low to moderate risk signficance / sufficient data available for regulatory decisions** **L = Low risk significance / large amount of data available**	**H = High** **MH = Medium-high** **M = Medium** **ML = Medium-low** **L = Low**
Importance of Harvested Materials over Laboratory Aging	Key considerations are the ease of laboratory replication of aging mechanism and unique field aspects of the aging mechanism. Degradation mechanisms that are harder to replicate with simulated aging conditions would be of higher priority for harvesting. For example, simultaneous thermal and irradiation conditions are difficult to replicate outside of the plant environment. Alternatively, accelerated aging may not be feasible for a mechanism sensitive to dose rate. These two degradation mechanisms may be best evaluated using harvested materials. For unique field aspects, legacy materials (e.g., fabrication methods, composition) that are no longer available, but may play an important role in a potential degradation mechanism, would have a higher priority than harvesting materials that can be obtained from other sources with representative properties.	**H = Nearly impossible to replicate service enviroment / critically important to use harvested materials** **MH = Challenging to replicate service enviroment / important to use harvested materials** **M = Possible with some limitations to replicate service enviroment / moderately important to use harvested materials** **ML = Not challenging to replicate service enviroment / less important to use harvested materials** **L = Very easy to replicate service enviroment / not important to use**	
Applicability to US Operating Fleet	There is greater value in developing knowledge to address an issue that may be applicable to a larger number of plants compared to one that may only affect a relatively small number of plants.	**H = All plants** **MH = All PWRs** **M = All BWRs or most PWRs** **ML = ~10-15 plants** **L = <5 plants**	
Regulatory Considerations Related to Inspections and AMPs	If mature inspection methods exist and are easy to apply to monitor degradation, harvesting may be less valuable. If inspection methods do not exist, harvesting may be essential to ensure confidence in the assessment of age-related degradation in that particular component.The less confidence that NRC staff has in the effectiveness of the relevant AMP, the higher priority for harvesting.	**H = No or very limited inspection methods available / low confidence in AMPs** **MH = Limited inspection methods available / low-to-moderate confidence in AMPs** **M = Some inspection methods available / moderate confidence in AMPs** **ML = Good inspection methods available / medium-high confidence in AMPs** **L = Effective, well-accepted inspection**	
Harvesting cost and complexity	Activities with higher costs and complexity are less attractive than similar activities with lower costs and that are simpler to execute.. For example, harvesting unirradiated concrete or electrical cables is less expensive and less complex than harvesting from the RPV internals or the RPV.	**H = Highly irradiated (>5 dpa)** **MH = Lightly irradiated / contaminated** **M = Minimal contamination or high effort unirradiated** **ML = Unirradiated, moderate effort expected** **L = Unirradiated, low effort expected**	
Timeliness of results	The ability of a potential harvesting program to provide timely results to support either a technical or regulatory need is important. Having high confidence that results will be timely increases the priority.		
Availability of materials for harvesting	The availability of materials to harvest for a particular data need is clearly essential and increases the priority.		

	Basic Info		Technical Criteria										Cost / Complexity		Project Specific	
Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Criticalness of Technical Gap Addressed		Importance of Harvested Materials over Laboratory Aging		Applicability to US Operating Fleet		Regulatory Considerations Related to Inspections and AMPs		Score Average	Basis for Priority			Timeliness of results	Availability of materials for harvesting
METALS			Score	Comment	Score	Comment	Score	Comment	Score	Comment			Score	Comment		
High fluence reactor internals	Void swelling, mechanical properties, IASCC	Likely extent of void swelling in PWRs during extended operation and impact on cracking													TBD	TBD
Thermally aged unirradiated CASS	Fracture toughness and microstructure	Fracture toughness data in real conditions to compare to accelerated aging data														
Moderate fluence (1-2 dpa) CASS	Fracture toughness and microstructure	Fracture toughness data near limit requiring further evaluation														
Metallic components with known flaws	NDE and destructive examination	Determine whether SCC mitigation methods are effective at preventing SCC; effectiveness of NDE at detection and sizing														
Metallic components with limiting fatigue life	NDE and destructive examination	Determine whether fatigue flaws are present in high usage locations														

Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Benefit / Significance	Cost	Alternative to Harvesting?	Priority / Value	Basis for Priority	Unique aspects of harvested materials	ISI availablility?
METALS									
RPV - High fluence & high shift vessel with well-established unirradiated properties	Measure fluence, toughness, & chemistry as a function of through-thickness position	Through thickness section to validate fluence & attenuation models	Increases confidence in existing regulatory approach	High	No	**LOW**	High cost not justified by benefit given surveillance specimens and well-established embrittlement trend correlations	Vintage compositions and irradiation conditions	
RPV - Samples from virtually any vessel	Enable measurement of both the Charpy transition curve and master curve transition temperature T0	Provides data supporting evolution from the use of correlative (Charpy-based) to direct measurement (fracture toughness-based) approaches	Increases confidence in existing regulatory approach	High	No	**LOW**	High cost not justified by benefit given surveillance specimens and well-established embrittlement trend correlations	Vintage compositions and realistic irradiation conditions	

Need Description ELECTRICAL	Purpose / Testing Planned	Technical Knowledge Gained	Benefit / Significance	Cost	Alternative to Harvesting?	Priority / Value	Basis for Priority	Unique aspects of harvested materials	ISI availablilitv?
Low and medium voltage cables				Medium		**HIGH**			
Cables protected with fire retardant coating				Medium					
1E MOVs from harsh and mild environments				Medium					
1E Air operated valves; 4160									
1E breakers				Low					
1E Molded case breakers 480V, 250V DC, 125 VDC,				Low					
1E Relays from mild environment GE – HFA, Agastat timing relays, any from Westinghouse, Potter Brumfield, Stuthers Dunn etc				Low					
Batteries				Low					
Electrical penetrations									
Fire research interest									
Electrical enclosures									
Distribution: switchgear, MCCs, LCs | Control: Horseshoe, SSCP, ASP, etc.									

Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Benefit / Significance	Cost	Alternative to Harvesting?	Priority / Value	Basis for Priority	Unique aspects of harvested materials	ISI availablility?
METALS									
CONCRETE									
Structures exposed to high radiation	Change in properties due to irradiation effects	Loss of strength due to irradiation	Fills data gap for extended plant operation	High		**HIGH**			
Post-tensioned structures				Medium		**LOW**			
Corrosion of reinforcing steel, tendon, liner, embedment				Medium		**LOW**			
Spent fuel pool and transfer canal-boric acid attack on concrete in PWRs				Medium		**LOW**			
Alkali Aggregate Reaction				Medium		**LOW**			
Large structural sections for testing	Effects of concrete aging on structural capacity		Validate assumptions of aging effects at larger scales	High		**LOW**			

Note to requester: Highlighted portions of this email document were in the original document provided to the FOIA team.

From: Frankl, Istvan
To: Purtscher, Patrick
Subject: RE: CONTRACTOR INADVERTENTLY RELEASED A DRAFT REPORT TO THE PUBLIC
Date: Friday, September 28, 2018 11:27:03 AM
Importance: High

Thanks, Pat.

I agree with Sandra's highlighted statement below. We need to close the loop with PNNL on this ASAP. This is very important given the fact that the released report was not marked draft and did not have disclaimer.

As discussed, I need status update on this before noon Monday so I can report on this to DE management at the DE weekly meeting at 1 PM.

Steve

From: Purtscher, Patrick
Sent: Friday, September 28, 2018 8:55 AM
To: Frankl, Istvan <Istvan.Frankl@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>; Tregoning, Robert <Robert.Tregoning@nrc.gov>; Audrain, Margaret <Margaret.Audrain@nrc.gov>; Hiser, Allen <Allen.Hiser@nrc.gov>
Subject: FW: CONTRACTOR INADVERTENTLY RELEASED A DRAFT REPORT TO THE PUBLIC

Latest status.

Pat

From: Nesmith, Sandra
Sent: Thursday, September 27, 2018 5:33 PM
To: OPA Resource <OPA.Resource@nrc.gov>
Cc: Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Subject: CONTRACTOR INADVERTENTLY RELEASED A DRAFT REPORT TO THE PUBLIC

One of our contractors, Pacific Northwest National Laboratory (PNNL), inadvertently released a draft report on their public website that was still incorporating comments from RES and NRR. This report was placed on their public website back in December 2017; however, staff in RES were just made aware of this at a public meeting yesterday. I don't think that the report contained any proprietary information or anything that could potentially be harmful to the NRC, but it did have incomplete information and included many statements about critical gaps in our knowledge related to aging components and structures that could be construed as NRC position.

PNNL has taken the report down and is working to find out what happened. However, is there anything more that we should do or ask PNNL to do, such as put out a notice that a draft report was inadvertently released, etc.? I'm not sure of everything that we do when this happens here at NRC. Patrick Purtscher is the COR for this particular contract so I

have also copied him on this email, and I am also including the email exchange below.

Any advice you could provide would be greatly appreciated.

Thanks

Sandra R. Nesmith
Operations Branch B
Acquisition Management Division
Office of Administration
Mail Stop: TWFN 7B39
U.S. Nuclear Regulatory Commission
Washington, DC 20555
(301) 415-6836
Sandra.nesmith@nrc.gov

From: Nesmith, Sandra
Sent: Thursday, September 27, 2018 2:05 PM
To: Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Subject: RE: issue with PNNL NRC-HQ-60-15-T-0023

Patrick,

I will have a short meeting with my boss about this later on this afternoon when she is available; however, I am thinking that PNNL should at least put out some type of notice that the report wasn't final and was inadvertently released. I have to check to see what we would do it happened here. They should also let us know what steps they will take in the future to ensure this doesn't happen again.

I will be in touch.

Sandy

From: Purtscher, Patrick
Sent: Thursday, September 27, 2018 1:29 PM
To: Nesmith, Sandra <Sandra.Nesmith@nrc.gov>
Subject: RE: issue with PNNL NRC-HQ-60-15-T-0023

It will be public once it is completed. The draft was started before GALL-SLR was complete and included many statement about critical gaps in our knowledge related to aging components and structures. The text implies that material harvesting from decommissioned and/or operating plants has to be done before SLR applications can be accepted.

Pat

From: Nesmith, Sandra

Sent: Thursday, September 27, 2018 1:23 PM
To: Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Subject: RE: issue with PNNL NRC-HQ-60-15-T-0023

Patrick

I haven't had this happen before so I will have to check with some of the other contracting officers here in AMD.

Was there any information that could potentially be harmful to the NRC? Would this report have been released to the public once final?

From: Purtscher, Patrick
Sent: Thursday, September 27, 2018 1:01 PM
To: Nesmith, Sandra <Sandra.Nesmith@nrc.gov>
Subject: issue with PNNL NRC-HQ-60-15-T-0023

Hi,

You were listed as the contract officer on this task order with PNNL. I took over as COR in May 2016. PNNL is finishing a report to complete phase 1 and PNNL released to the public by accident.

I am not sure how we should proceed. Are they any precedents for how to address this?

Pat
415-3942
Good evening,

From: Purtscher, Patrick
Sent: Wednesday, September 26, 2018 3:51 PM
To: Frankl, Istvan <Istvan.Frankl@nrc.gov>; Alley, David <David.Alley@nrc.gov>; Ruffin, Steve <Steve.Ruffin@nrc.gov>
Cc: Hiser, Allen <Allen.Hiser@nrc.gov>; Rudland, David <David.Rudland@nrc.gov>; Tregoning, Robert <Robert.Tregoning@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>; Audrain, Margaret <Margaret.Audrain@nrc.gov>
Subject: RE: RES Follow-up on Gunter question during today's public meeting re. PNNL harvesting report

All,

Looks like PNNL publications folks have pulled it back from a public listing.

PNNL is not sure how it got loose, but apparently somewhere along the way it got listed in the system as unlimited distribution and was posted to OSTI. PNNL is still trying to figure out what went wrong and how it got past the multiple checks they have in place to avoid precisely this issue.

We should talk more about this tomorrow.

Paat

From: Frankl, Istvan
Sent: Wednesday, September 26, 2018 2:43 PM
To: Alley, David <David.Alley@nrc.gov>; Ruffin, Steve <Steve.Ruffin@nrc.gov>
Cc: Hiser, Allen <Allen.Hiser@nrc.gov>; Rudland, David <David.Rudland@nrc.gov>; Tregoning, Robert <Robert.Tregoning@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>; Audrain, Margaret <Margaret.Audrain@nrc.gov>
Subject: RES Follow-up on Gunter question during today's public meeting re. PNNL harvesting report
Importance: High

All:

This morning it was brought to my attention that during today's public meeting Gunter referenced the PNNL report on harvesting. Needless to say that RES staff was quite taken aback by this. As you're aware, this report is still in draft form and is currently incorporating comments from both RES and NRR. We've gone back and found that, unbeknownst to RES, the report was placed on the PNNL public website back in December 2017. What Gunter has is therefore an early version of the draft report that doesn't include several rounds of NRC comments. However, there is no indication within the report released on the website that the report is still a draft and the inside cover also indicates, correctly, that the work was done under NRC sponsorship. This leaves the impression, as reinforced by Gunter, that the contents of the report could be construed as NRC position.

RES is taking the follow immediate action.

1. We are working with PNNL to get the report removed from the public website as soon as possible.
2. We are trying to determine how this happened and what remediation steps are appropriate for this particular action.
3. Based on our findings, we will be recommending procedural changes in how PNNL releases information to the public for NRC-sponsored research.

Thanks,

Steve